The Engineer

LONDON, FRIDAY, MAY 2, 1941.

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

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"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, June 27th.

ADVERTISEMENTS

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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The Engineer
ENQUIRY DEPARTMENT

The fact that our Enquiry Department is unquestionably filling a want in the engineering world daily becomes more apparent, and the Proprietors of "The Engineer" welcome enquiries from all who require information of a technical or commercial nature.

This Department contains an extensive trade name index, a large technical library, and catalogues of most of the prominent manufacturers.

A Seven-Day Journal

The British Canal Industry

IN the course of his chairman's address at the annual general meeting of the Grand Union Canal Company, which took place in London on Thursday, April 24th, Mr. John Miller made reference to the future of Britain's canal industry. He welcomed, he said, the appointment by the Minister of Transport of Mr. Frank Pick to investigate the position and possibilities of the canal industry as a whole. Before the war, Mr. Miller said, the competition between rail, road, canals, and coastwise shipping had created such an impasse that no form of transport was receiving a fair reward, and the enormous amounts of capital which were invested in the canal industry could never hope for even a moderate return. That state of affairs could be obviated by a system of co-ordination of all transport, with rate structures built up and differentials agreed upon in favour of the slower routes and methods of transport such as canals and coastwise shipping. His own view, Mr. Miller said, had always been that the railways should cease being owners of or having interests in canals. How could the canal industry expect the railways to develop their waterways on modern lines, he asked, when it was against their interests to do so? He suggested that the canals controlled or owned by the railway companies should be transferred to the canal undertakings, and that, on similar lines to the railway amalgamation, four canal groups should be formed and given the necessary Government assistance to enable the transfers to take place. The very heart of the canal industry from the traffic standpoint was in the Midlands, and real development could not take place until the railway companies released their stranglehold and ceased to be concerned with canals. Birmingham as an inland port was no dream. Mr. Miller expressed the hope that when the war was over and when the problem of having to find employment for men came to be dealt with the Government would realise how far behind this country was in the development of inland water transport, compared with Germany, Belgium and France, and that serious steps would be taken in order to remedy this position. The cost of the transport of raw materials was too high if this country was to compete in the world's markets.

Loss of H.M.S. "Rajputana"

LAST week it was announced with regret by the Board of Admiralty that the armed merchant cruiser H.M.S. "Rajputana," under the command of Captain F. H. Taylor, D.S.O., R.N., had been torpedoed and subsequently sank. The "Rajputana" was one of the "Ranchi" class of ships built for the Peninsular and Oriental Steam Navigation Company's Indian mail service. Like her sister, the "Rawalpindi," she was built at Greenock and engined at Belfast in 1925. The principal dimensions of the "Rajputana" were as follows:—Length, 570ft., and draught 28ft. 9in., with a gross tonnage of 16,500. The propelling machinery comprised a twin-screw arrangement of balanced quadruple-expansion engines taking steam from oil-fired boilers, with a working pressure of 215 lb. per square inch. The liner was for many years a popular ship in the P. & O. Company's Indian service, and she will be remembered by the many passengers who travelled in her.

Merchant Shipbuilding in the British Empire

A RECENT announcement concerning the building of merchant ships in the British Empire, issued by the Dominions and Colonial Offices, states that in addition to building naval vessels the British Dominions and Colonies are planning to add valuable tonnage to the Empire's merchant navy. To this end shipyards are being extended to cope with important new ship building programmes, and dry docks and repair yards are increasing their resources for the reconditioning of existing ships. Australia has allocated £6,000,000 as a first instalment towards the construction of new merchant ships. A preliminary survey of shipyards and engineering workshops has been made, and it is hoped to lay the keels of a number of 10,000-ton vessels within four months. Besides increasing her Navy to over two and a-half times its pre-war strength and fitting out a large number of armed merchant cruisers and auxiliary war vessels, Australia has defensively equipped over 150 merchant ships. Since the beginning of the war the shipyards at Auckland and other New Zealand ports have been working at high pressure on the construction of ships for coastal trade, the building of minesweepers, the conversion of liners into transports and hospital ships, and the equipping of merchant vessels for self defence. Canada is building twenty merchant vessels and hundreds of small craft in addition to a large number of destroyers, corvettes and minesweepers. In the dockyards at Hong Kong, where facilities have already been extended, several new tramp ships are now under construction. Small craft for coastal trade are being built at Singapore, where the 20 square miles of deep water anchorage, large dockyards and repair facilities provide a valuable base for merchant ships as well as for naval vessels. Dockyards in South Africa have been working at full pressure to speed up repairs, and the South African Government has set up a new organisation to eliminate congestion at the larger ports, particularly at Durban, which has the fifth largest graving dock in the world. From Mombasa, the principal port of British East Africa, it is reported that there has been a large increase in the number of ships registered locally.

The General Council of British Shipping

ON Thursday, April 24th, the Chamber of Shipping of the United Kingdom and the Liverpool Steam Ship Owners' Association announced that they had agreed on certain arrangements which were designed to ensure unity of action and policy on questions of major importance to the industry as a whole. While these arrangements provide for the closer co-operative working between the two bodies, the identity and individuality of each remains unimpaired. A General Council of British Shipping is to be formed immediately, which will be representative of the two organisations and of all sections of the shipping industry, including liners, cargo vessels, coasters and oil tankers. The Council will consist of about twenty members and its functions will include the investigation of problems falling within its terms of reference and the co-ordination of the views of the different sections of the industry formulated within the two organisations and passed to the Council for final settlement. With a view to strengthening the existing arrangements for co-operation between the Liverpool Steam Ship Owners' Association and the liner section of the Chamber of Shipping, a new British Liner Committee, which will be representative of the liner interests of the two bodies, is to be set up. Membership of this new Committee will be open to the members of the Deep Sea Liner Committees of both organisations and the Committee will meet from time to time in London or in Liverpool. It is not necessary to establish a separate organisation for tramp vessels, as such a body already exists in the Standing Committee of the Deep Sea Tramp Section of the Chamber, which will continue to function as the executive body to deal with tramp matters in general, and the Tramp Section will have representatives on the General Council. It is further announced that Mr. P. Maurice Hill, the general manager of the Chamber of Shipping, and Mr. Martin Hill, a joint secretary of the Liverpool Steam Ship Owners' Association, have been appointed to act as joint secretaries of the new General Council and the Liner Committee, which will both operate from the building in Bury Court, London, E.C.3, where the Chamber has its offices. At a meeting of the Council of the Chamber held on Thursday it was announced that the retirement of Mr. H. M. Cleminson, who has been the general manager of the Chamber since 1916, has been accepted on the grounds of ill-health. The Council has appointed the deputy general manager, Mr. Maurice Hill, to succeed Mr. Cleminson.

New Transport Officers to Assist Exporters

THE Board of Trade announces the appointment of new Transport and Progressing Officers to most Area Boards with the object of assisting exporters. We may recall that in each of the Civil Defence Areas a Board of Trade representative has already been appointed, one of whose main duties is to assist exporters to overcome any difficulties which may be encountered in the course of their business. In many cases the problem of transport has offered particular difficulty, and new officials known as Board of Trade Transport and Progressing Officers have therefore been appointed, to assist the Board of Trade representatives. Exporters are urged to take full advantage of the services which these officers are able to give. In the list which follows we give the title of the Area Board, the name and address of the Board of Trade representative and the Board of Trade Transport and Progressing Officer. Northern Area, Dr. J. T. Batey, Northern Area Board, Clarendon House, Clayton Street West, Newcastle-on-Tyne, Mr. R. P. Spencer; East and West Riding Area, Mr. Colin Laycock, Sheffield Chamber of Commerce, Cutlers' Hall, Sheffield, Mr. R. Thomas; North Midland Area, Mr. A. Geoffry Howitt, Alfred Street Mills, Nottingham; Eastern Area, Mr. S. C. Roberts, University Press, Cambridge; London and South-Eastern Area, Sir E. Crowe, Brettenham House, Lancaster Place, W.C.2; Southern Area, Captain H. W. Weathersbee, Horlicks, Ltd., Slough, Mr. E. P. Bateman; South-Western Area, Captain B. H. Peter, Westinghouse Brake and Signal Company, Ltd., Chippenham, Wilts, and 82, York Way, London, N.1, Mr. C. J. Flock; All Wales Area, Mr. John Powell, Baltic House, Mount Stuart Square, Cardiff; Midland Area, Mr. A. H. Godfrey, C.M.L. Buildings, Great Charles Street, Birmingham, 3, Captain P. Stewart; North-Western Area, Sir Thomas Barlow, 3, Brazil Street, Manchester, Mr. A. Steuart; All Scotland, Mr. Norman L. Hird, Union Bank of Scotland, Ltd., 110, St. Vincent Street, Glasgow, C.2, Mr. W. A. Mitchell; All Northern Ireland, Mr. W. D. Scott, Ministry of Commerce for Northern Ireland, Chichester Street, Belfast. In the case of the North Midland, Eastern London and South-Eastern and Wales Areas the appointments of Transport and Progressing Officers are under consideration and for the time being the duties of such an officer will be carried out by the Area Board representative.

Mechanical Mishaps

ON Friday, April 18th, Mr. G. E. Windeler gave a delightful address on "Mechanical Mishaps" at a general meeting of the Institution of Mechanical Engineers. He brought to Storey's Gate a number of samples illustrating failures that had occurred within his own experience and with the help of sketches on the blackboard described the nature of the failures, the causes, and the cures. It was astonishing to find that many of them were due to such an obvious defect as omission to test that lubricating passages were clear. In one case a twist drill had broken off short in the oil passage and had not been removed under the belief that the oil would pass down the flutes. Mr. Windeler easily demonstrated that swarf from the drill had practically plugged the passage so that hardly any oil passed. In another case a long oil hole had been driven into a shaft from opposite ends; the two holes failed to meet. Other cases, involving breakages, were due to such causes as the insufficient stiffness of a fabricated bed-plate, the maltreatment of special steels by reheating for one reason and another, and in one notable instance the stressing of a part by bending when two contacting surfaces were not parallel to each other. Apart from mechanical breakdowns, Mr. Windeler dealt at some length with the Manchester accident of July, 1938, when three men were "drowned" in CO_2 in a pit dug during work on the sewage system. The pit was 50 feet deep and at the summit were two I.C. engines, one driving a compressor and the other a hoist. The exhausts from these engines delivered just over the pit mouth, and Mr. Windeler was able to show by evidence which would satisfy a jury of engineers that owing to the climatic conditions at the time of the accident the CO_2 from the products of combustion had settled in the excavation and partly filled it. The story as he told it was as dramatic as it was instructive.

New Railway Appointments

ON Monday, April 28th, it was announced that the directors of the London and North-Eastern Railway Company had appointed Mr. E. Thompson as Chief Mechanical Engineer, in succession to the late Sir Nigel Gresley. It was further announced that the headquarter offices of the mechanical engineering department will be transferred at an early date from London to Doncaster, and that Mr. W. H. Richards has been appointed Chief Electrical Engineer, and will have complete responsibility for the company's electrical engineering work. Mr. Thompson received his education at Marlborough and Pembroke College, Cambridge. He was a pupil with Beyer, Peacock and Co., Ltd., and served some time with the Midland Railway before taking an appointment at the Royal Ordnance Factory, Woolwich, as supervisor. In 1906 he joined the staff of the North-Eastern Railway, and was appointed assistant divisional locomotive superintendent at Gateshead in 1909. He visited America with the late Sir Vincent Raven, in connection with railway electrification schemes. In 1912 he was appointed carriage and wagon superintendent for the Great Northern Railway at Doncaster. He served in the Royal Engineers in the last war, and attained the rank of Lieut.-Colonel, with the award of the O.B.E. in the Military Division. After the war Mr. Thompson was appointed carriage and wagon works manager at York, becoming in 1923 the carriage and wagon works manager for the London and North-Eastern Railway, North-Eastern Area. In 1927 Mr. Thompson was appointed assistant mechanical engineer at Stratford, and became mechanical engineer in 1930. In 1934 he was transferred to the North-Eastern Area as mechanical engineer, and in July, 1938, he was appointed mechanical engineer of the Southern Area, Western Section. On Saturday, April 26th, it was officially announced that the directors of the London, Midland and Scottish Railway Company had elected Sir Thomas Royden, Bart., chairman of the company, in succession to the late Lord Stamp. Sir Thomas, who was born in 1871, is director and chairman of several shipping and power companies. Mr. Robert A. Burrows, who becomes deputy chairman, is chairman of Lancashire Associated Collieries, and a director of the National Boiler and General Insurance Company.

50,000-kW 3,000 R.P.M. TURBINE FOR BUNNERONG, AUSTRALIA

(For description see opposite page)

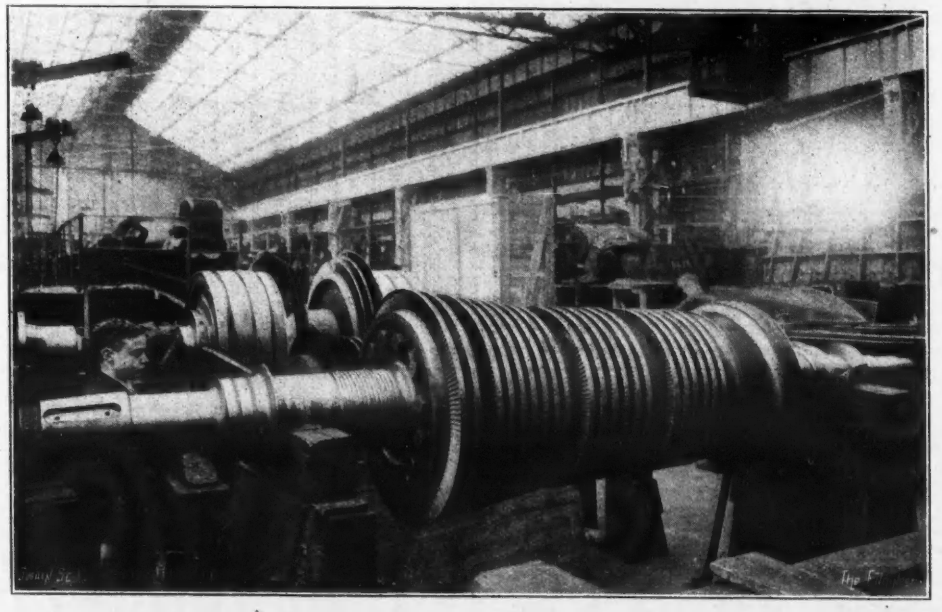


FIG. 1—H.P. ROTOR

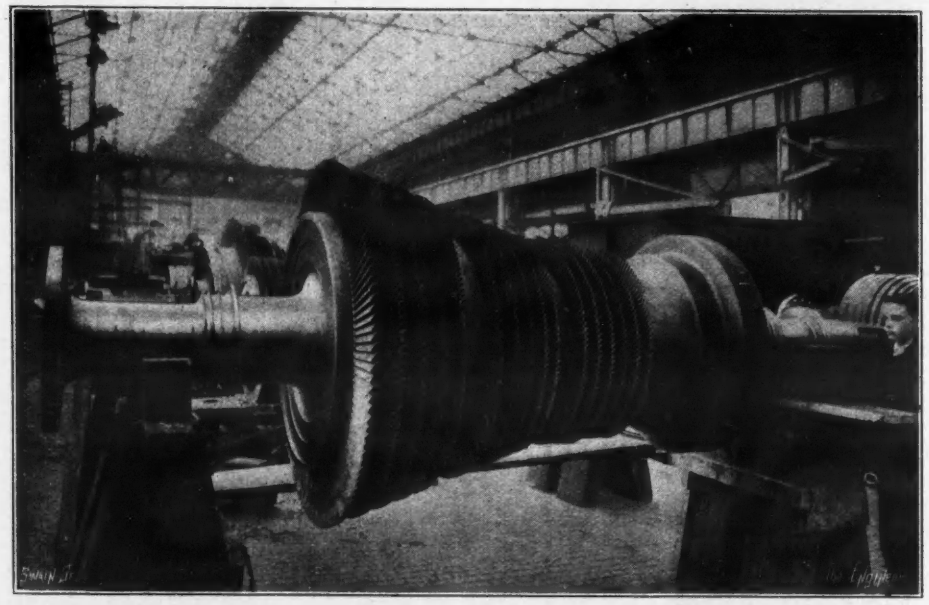


FIG. 2—I.P. ROTOR

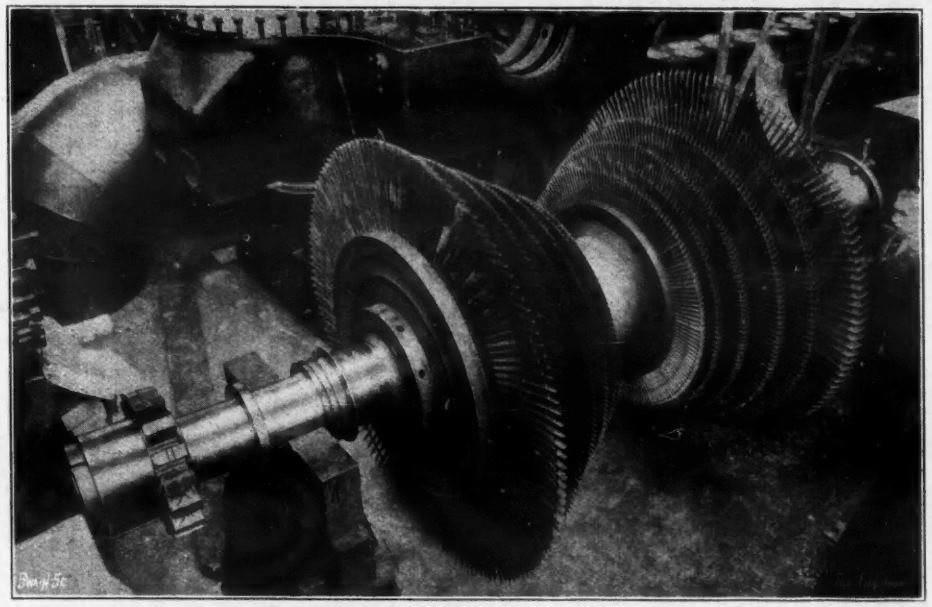


FIG. 3—L.P. ROTOR

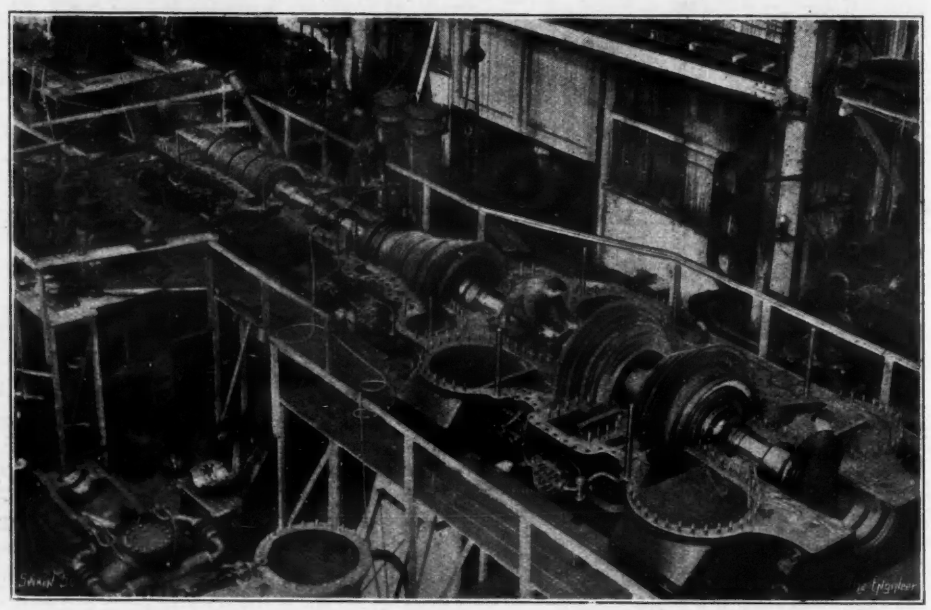


FIG. 4—PARTIALLY ERECTED TURBINE

50,000-kW Turbo-Alternator for Bunnerong

No. I

THREE thousand revolutions per minute is the highest possible speed for an alternator supplying current at the standard frequency of 50 cycles, and this speed would be preferred for direct-coupled machines of every size were economy of material the only question, especially as the next lower speed available to the designer is only 1500 r.p.m. The combination of high speed and large output, however, introduces constructional problems which become more serious as the output is increased. The progress that has been made in high-speed machines will be evident from the fact that twenty years ago the largest 3000 r.p.m. direct-coupled generating unit in service was a tandem machine of 12,500 kW built by Messrs. C. A. Parsons and Co. for the Mersey Power Company. By 1925 the same makers again led the way with units capable of an output of 30,000 kW at 3000 r.p.m., and there are now a very large number of sets of this size and speed in service at home and abroad. For the units of 50,000 kW, which have been coming increasingly into use of recent years, the speed of 1500 r.p.m. has hitherto been generally adopted in this country, and it has consequently tended to become standardised.

The first opportunity for a British firm to supply turbo-alternators of 50,000 kW running at 3000 r.p.m. was afforded by the County Council of Sydney, N.S.W., in connection with extensions required for their Bunnerong station. The plant already installed consisted of seven 25,000-kW, 3000 r.p.m. sets, the ultimate designed capacity of the station being 400,000 kW. For the purpose of the extensions, two 50,000-kW sets were called for, the specifications being prepared by Mr. Forbes MacKay, the General Manager and Engineer to the Sydney County Council, who gave tenderers the option as to speed of revolution. In the light of the offers received the Council placed the order for machines at the higher speed of 3000 r.p.m. with Messrs. C. A. Parsons and Co., who already had to their credit units of 40,000 kW at 3000 r.p.m. running in South Africa.

The contract provided for the supply and erection of two turbo-generators, complete with condensing plant and auxiliaries, each unit having a maximum continuous capacity of 50,000 kW at 3000 r.p.m. The surface condensers, air ejectors, extraction pumps, feed-water heaters, and evaporators were manufactured in Australia to the designs of Messrs. C. A. Parsons and Co. The turbines were required to operate with steam at 600 lb. gauge pressure, superheated to 825 deg. Fah. at the stop valve, and exhausted at a vacuum of 28·5in. (bar. 30in.) at their most economical load of 40,000 kW. Each turbine drives a three-phase alternator generating at 11,000 volts, this pressure being raised to the bus-bar pressure of 33,000 volts by directly connected transformers.

A photograph of one of the 50,000-kW units erected in the station at Bunnerong is reproduced in Fig. 5, and other photographs showing the working parts of the turbine are given in Figs. 1 to 4 on the opposite page. The turbine consists, as will be seen from the illustrations, of three cylinders in tandem, connected by flexible couplings. In the high-pressure cylinder the steam is expanded from the stop-valve pressure of 600 lb. gauge, down to a pressure of approximately 150 lb. absolute. It is then led by a pair of underground pipes to the intermediate-pressure cylinder, in which its expansion is carried down to about 12 lb. absolute, at which pressure it passes to the double-flow low-pressure cylinder and thence to the condenser.

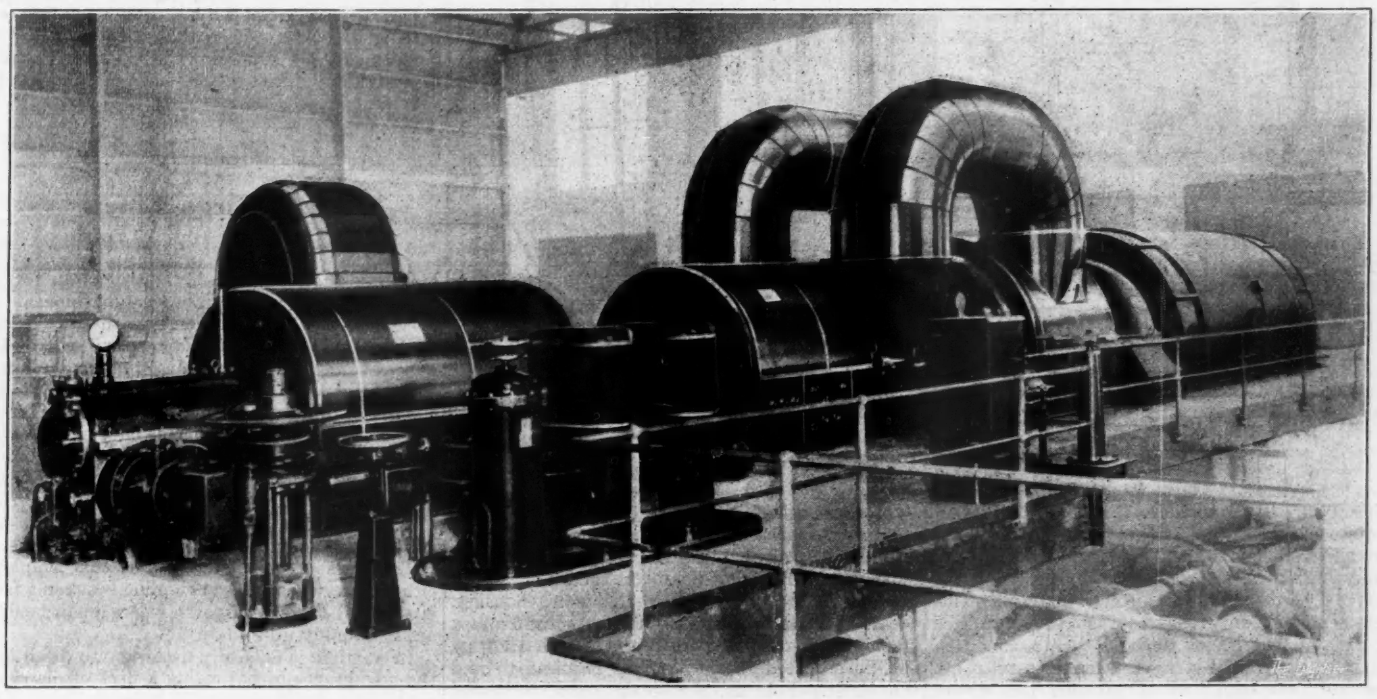


FIG. 5—50,000-KW 3,000 R.P.M. TURBO-ALTERNATOR IN BUNNERONG POWER STATION

THE HIGH-PRESSURE CYLINDER

The casing of the high-pressure cylinder is of cast steel throughout, including the exhaust portion, and steam is admitted to the main inlet belt and to the by-pass belt, both at top and bottom. This arrangement not only secures a better distribution of the steam, but it also permits of the belts being reduced in radial width as they approach the horizontal joint of the casing, so that the line of the bolts can be kept almost straight. The rotor is a hollow forging, integral with the shaft at the high-pressure end, and closed at the other by a forging which is extended to form the other end of the shaft. This method of construction enables the metal forming the body of the rotor to be made comparable in thickness with that of the steel cylinder surrounding it, and thus obviates difficulties due to differential expansion of rotor and cylinder when temperature changes occur. The quality of the metal is also improved, while the possibility of internal defects is eliminated. The high-pressure rotor, shown independently in Fig. 1, carries twenty-one rows of end-tightened blading, of which the first six are by-passed automatically at loads above 40,000 kW. The advantage of end-tightened blading is that steam leakage between successive blade rows can be perfectly controlled by the axial position of the rotor, so that any desired clearance may be allowed over the blade tips without loss of efficiency. This feature is particularly important in the high-pressure portion of the turbine where the steam is dense, the blades relatively short, and temperature variations are greatest. For the purpose of leakage control the rotor is provided with longitudinal adjustment in the cylinder. The mechanism is illustrated in Fig. 7. The high-pressure end of the shaft runs in a combined bearing and thrust block which locates the rotor axially in the cylinder, thus maintaining the desired clearance between fixed and moving blade rows. The thrust block also takes the slight unbalanced end pressure on the rotor, which is directed towards the steam inlet end. The thrust collar on the shaft runs between two sets of pivoted pads which are held in rings mounted in the thrust block. The pads are of the Michel type, pivoted slightly off centre to assist in the formation of the oil film. To ensure that the pads should be assembled on the correct sides of the thrust collar, the dovetails which hold them are slightly different on the two sides and the outside diameters of the rings are also different.

Oil is supplied to the thrust pads and bearings through the holes A in the block. These holes are larger in diameter than the drain holes B so that the latter control the quantity of oil to the pads. To ensure the correct distribution of oil between loaded and idle thrust pads, a baffle strip C is fitted in the block to separate the oil systems of the two faces. The position of the thrust block is adjustable within definite limits by means of a pair of drawing screws, driven by a pair of worms and worm wheels which are operated from the side of the pedestal. The limits of movement are fixed by liners L 1 and L 2 at opposite ends of the block.

THE INTERMEDIATE-PRESSURE CYLINDER

The whole of the bladed portion of this cylinder is of cast steel, cast iron only being used for the exhaust branch at the end. The rotor, including the two shaft ends, is a solid steel forging bored through from end to end in order to enable the interior to be inspected by means of a borescope, and samples of the internal metal to be tested. A photograph of the completed rotor is shown in Fig. 2. The rotor carries sixteen rows of moving blades divided into three groups, between which steam is tapped off at two places for feed heating. The blades in the intermediate-pressure cylinder are of the radial clearance type, as their greater lengths and the lower density of the steam render end tightening unnecessary. The belts from which the steam is taken are provided with guiding lips on the downstream side. The arrangement of one of these guide lips is shown in the photograph reproduced in Fig. 8, which, however, has been taken from a cylinder having end-tightened blades that has been fitted with the device in question. The object of the guide is to enable the required quantity of steam to be withdrawn without interfering with the direction of the main flow into the

next ring of blades in the cylinder. The rotor is maintained in its axial position by its own thrust block which is integral with one of the bearings, and is flexibly coupled to the rotors of the cylinders at either end.

The Low-pressure Cylinder

Steam enters the low-pressure cylinder at the centre of its length and flows to an exhaust at each end. The thrust on the blading is thus balanced, and no dummy pistons are necessary, while the blading, having only to deal with half the flow, can be kept a reasonable length. The rotor, shown independently in Fig. 3, is constructed of discs shrunk on to the shaft, the discs

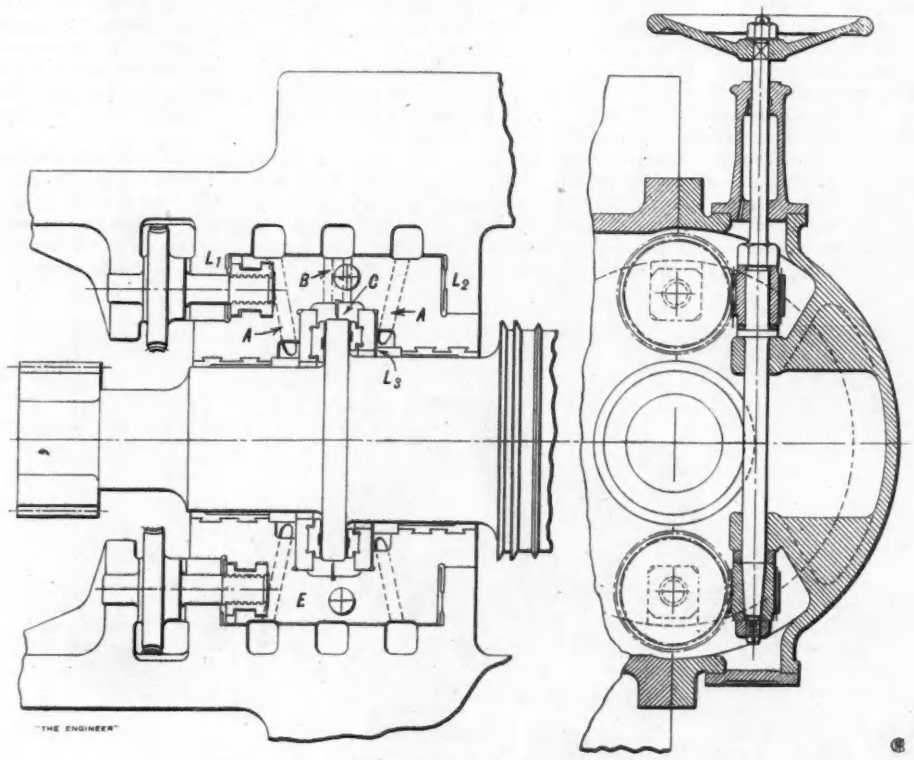


FIG. 7—THRUST ADJUSTING GEAR

being of such proportions that axial vibration is quite out of the question. The shaft is bored through from end to end, and the discs, before being shrunk on, are run up to a speed sufficient to give a permanent stretch to the material. This treatment not only ensures that they are free from flaws, but leaves them in such a condition that the centrifugal stresses when in service are more or less equalised throughout the metal. Steam is tapped off at corresponding points towards each end of the cylinder for feed heating, and there is also a drainage belt round each end

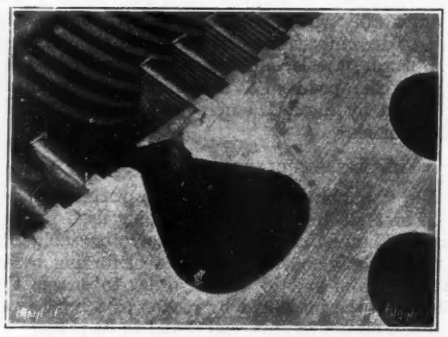


FIG. 8—STEAM EXTRACTION BELT

before the last row of fixed blades to eliminate as much as possible of the water entrained in the steam. Such moisture as remains is rendered harmless by the fitting of erosion shields to the last rows of moving blades. These shields consist of hard tungsten steel strips brazed to the leading edge of the blades, and they have been found to afford perfect protection against erosion. Another particularly interesting feature of design is to be found in connection with the final rows of running blades. Because of the high speed of the turbine and the comparative length of these blades, the stresses due to centrifugal force are quite appreciable. To minimise the stress in the blades and the loading on the wheel caused by this force, the blades have been made hollow from end to end by a special process of manufacture devised by Messrs. Parsons. The working part of the blade is integral with its root, and the internal cavity is of the same cross-sectional form as the blade, which tapers in its length so that the walls of the blade become progressively thinner towards the tip. Each blade, together with its root, is rolled from a separate billet, just as in the case of the ordinary Parsons integral blades.

The Design of the Glands

The shafts of the intermediate-pressure and low-pressure cylinders are rendered steam-tight by steam-packed carbon glands. These glands consist of four sectional carbon rings, the parts of each ring being held together by an arrangement of springs. The ring floats on the shaft and is prevented from rotating by the gland housing. Steam is led to the centre of each gland from a steam-distribution box, where the quantity flowing can be adjusted to the amount required to seal the gland. Between the steam-sealing belt and the outer end of the gland is a leak-off belt, whence the sealing steam escapes to a small condenser, where it is cooled by main condensate at atmospheric pressure. This prevents the nuisance of steam escaping into the turbine room. The condensed sealing steam drips into a tundish at the side of the turbine and thus gives a visible indication of the amount of steam admitted to the gland. There is also a pipe from the top of each condenser to the top of the cylinder cleading. This serves as a relief and as a vent at starting up.

The glands of the high-pressure cylinder are of the composite type. Each of them comprises a carbon gland of the type described above, but before the leakage steam reaches this it has to pass through a length of labyrinth packing, which reduces its pressure. Between the end of the labyrinth and the carbon rings is a leak-off, the steam from which is taken to the exhaust of the intermediate-pressure cylinder, where the pressure is slightly below atmospheric.

Motor-driven Turning Gear

The machine is equipped with motor-driven turning gear, by means of which the turbine can be kept in slow rotation during the periods of warming up and cooling. This prevents the inequalities of temperature that would otherwise occur, and enables the machine to be run up to speed very quickly from either the cold or the half-hot condition without fear of vibration. The use of the turning gear also avoids the necessity of suddenly admitting a large quantity of hot steam in order to start the machine from rest, and thereby saves the valve chests and cylinders from severe temperature stresses. The turbine is driven by a toothed ring attached to the coupling between the high-pressure and intermediate-pressure cylinders. The pinion which gears with this ring is mounted on a short countershaft driven by an electric motor through worm gear. The pinion rides on a spiral feather, along which it can be slid into gear with the ring by the operation of an external hand lever. The latter is loose on its fulcrum so that, once the pinion has been engaged, the hand lever can be withdrawn to its "rest" position without disengaging the pinion. As soon as sufficient steam is admitted to the turbine to cause it to gather speed and tend to overrun the slow-speed driving gear, the pinion automatically slides out of engagement with the toothed ring of the coupling and the gear is free. A spring-controlled plunger holds the pinion clear of the ring when the turning gear is not in service, and thus prevents accidental re-engagement when the turbine is running. The engagement or otherwise of the gear is shown to the operator by the position of a small index outside the casing.

High-pressure Oil Pump

The work of the turning gear is reduced, and the bearings are protected when the turbine is being started, by the admission of oil beneath the journals at sufficient pressure to lift the rotors and float the shaft on an oil film. The oil is supplied by means of a high-pressure oil pump driven by a small electric motor. The pump is designed with single-acting rams, one to each bearing to be served, so that each gets its own independent oil supply. The pump is capable of delivering oil at a pressure of 2000 lb. per square inch.

(To be continued)

Fast Cargo Liners

(By a Special Correspondent)

While there is probably justification for the construction of many tramp cargo ships at the lowest cost price, and hence with low-powered engines and consequent low speed, there does appear to be an overwhelming case for building a class of fast cargo liners, not only for war needs, but equally so to meet the fierce competition of foreign interests when peace conditions once more prevail. It is not proposed to take into account accommodation for up to twelve passengers on these fast liners, as that is a side issue, the value or otherwise of which is likely to be determined by unpredictable post-war conditions.

The class of ship envisaged is that employed either on regular routes or running between a fairly circumscribed range of ports, where repair facilities are reasonably up-to-date.

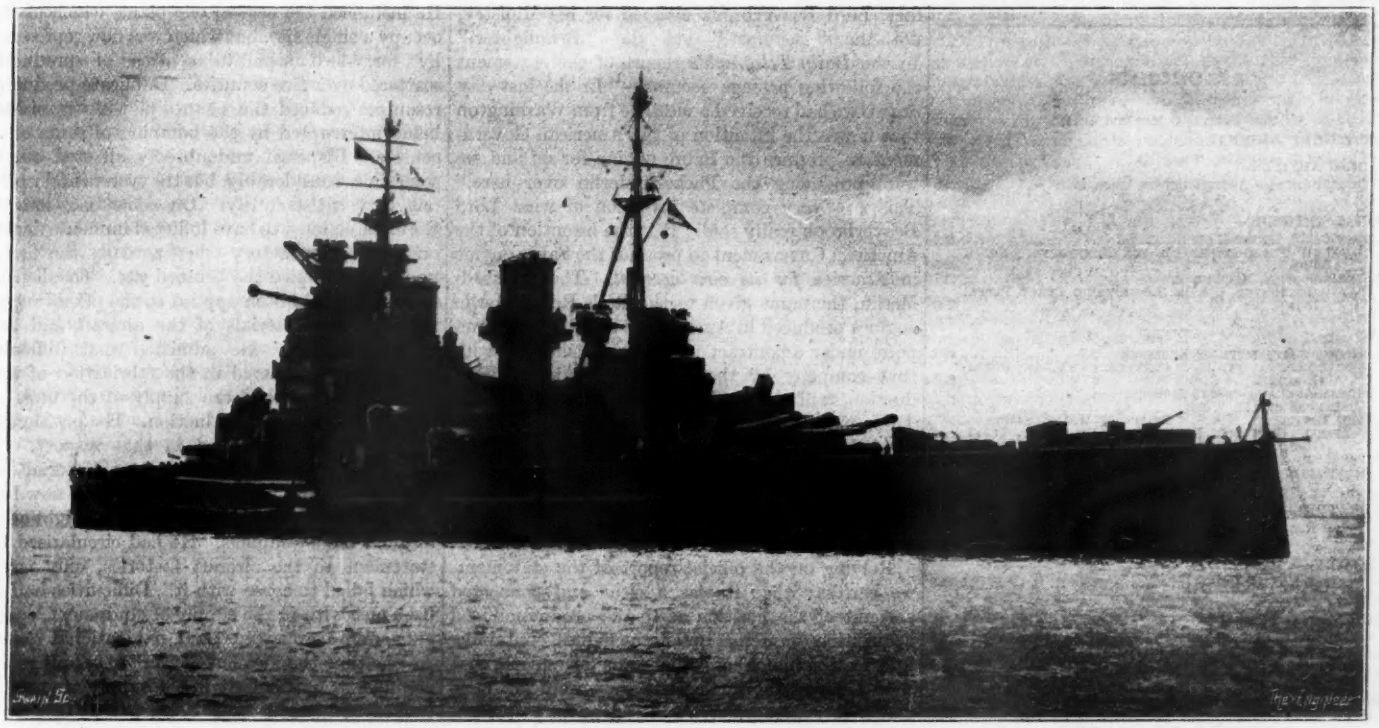
In wartime it is hardly necessary to dwell upon the advantages of possessing a fleet of merchantmen which could average 16 knots as against the 8 knots which, alas, is all that can be expected from many of the vessels pressed into service for victualling and munitioning these islands. Quite apart from the shorter time convoys of the faster ships would be in dangerous waters, where they require the close protection of the Navy, the faster ships would be able to make many more voyages a year and increase greatly the tonnage brought across the waters in a given period of time. Their higher speed, too, would give them some protection against under-water enemy craft.

In quite recent years certain engineering societies have published papers and groups of papers dealing with improved machinery for cargo vessels of the slower types, 8 to 10 knots, and 12 knots. The effects of increasing speeds up to 18 knots have been laid out clearly in some cases, but no strong advocacy was given to these higher speeds. The drawbacks have been stressed rather than the gains. The subject was dealt with from the engineering standpoint, and it was made clear that the call for such fast ships had to come from the shipowner rather than from the shipbuilder. It was not like the motor-car industry, where Henry Ford and other makers say, "Here is the 1941 model, none are made to private specification."

When the papers referred to above appeared there were not lacking men who foresaw the probability of our requiring to operate our merchant navy in convoy in a not-too-distant future, and these men would have liked to champion the cause of the faster ships and challenge the authors of a symposium on 10-knot ships as being entirely retrograde and lacking in vision. At the time, however, peace was filling the foreground. Rearmament—yea, even self defence—was in the

H.M. BATTLESHIP "PRINCE OF WALES"

CAMMELL LAIRD AND CO., LTD., BIRKENHEAD, BUILDERS



background, hidden as far as possible by a forest of trees labelled finance, economy, social reforms. Hence the advocates for fast ships did not dare to raise their voices in protest, lest they be merely accused of warmongering, or seeking to cultivate profitable markets for themselves in war weapons.

Whilst it is realised that these faster ships are more expensive to build for a certain deadweight carrying capacity and are more expensive to equip, factors of the most grave concern in the present crisis, the advantages of the higher voyage speeds in war would appear greatly to outweigh these drawbacks, while under peace conditions it is difficult to see how the competition of fast foreign tonnage can be countered unless our owners are prepared to meet their rivals on at least equal terms.

These views were endorsed emphatically when, speaking to the Chamber of Shipping of the United Kingdom on February 27th, 1941, Lord Rotherwick stressed the need for building many fast cargo liners.

For convoy work even a moderate speed of 15 knots as against 10 represents an obvious gain not needing a mathematician to expound, especially as port-to-port voyages are so prolonged, as many of them have to be to avoid enemy attentions.

In one of the sets of papers referred to above it was indicated that ships making voyage speeds of 18 knots had not nearly reached their maximum earning capacity, measured in ton-miles carried per annum, provided their machinery was of economical type for the power employed. There exist, too, a number of British ships with voyage speeds of 15 knots and over—with ability to go a little faster at a pinch—so there is evidence available as to voyage results, which after all form the criterion by which the shipowner judges the value of prospective new tonnage.

Travelling the seas on a 15-knot cargo boat, one keeps one's eyes particularly open for other ships in the same class, and sailing in and out of home and foreign ports it is disconcerting to meet, or fail to overtake, Dutch, German and Japanese ships, making a similar round of ports at a speed of one or two or even more knots faster still.

Quite apart from the need of these higher speeds to meet foreign competition (and they are faster because their owners calculate their higher speed pays), the faster ships have the ability to earn more freight in a year and are more flexible in operation. For example, with a little reserve of speed they can go a little out of their way to pick up or drop parcels of cargo; they can at times save very expensive overtime cargo handling charges by waiting till a local holiday is passed and by waiting on storms may save themselves damages from heavy weather.

Of course, in building these fast ships every advantage must be taken of the most recent advances in engineering and science. The bluff bowed merchantman, recalling Noah's design, must be changed for the tank-tested streamlined hull. Quite beautiful are the lines, both fore and aft, of these faster ships, when seen in dry dock. More beautiful than similar views of many a well-known passenger liner. Their top sides, too, are very pleasing to the eye, even among a dock full of liners.

For the power unit the oil engine, by reason of intense competition among many types, has achieved great modernity and efficiency. The steam engine, however, has but rarely been admitted in its most modern form to the engine-rooms of cargo boats.

The United States Maritime Commission has just launched a turbine-driven cargo boat with a steam pressure of 1200 lb. per square inch and reheat between the three stages of expansion. While this may be overstepping the mark, which time and experience alone will show, there seems to be no reason why water-tube boilers, steam pressures of the order of 400 lb. per square inch, and superheat up to 750 deg. Fah. should not be tried. There is plenty of experience of such conditions in our leading passenger liners, and the British India Company has started a series of ships operating successfully under these conditions in the Far East, with coal-fired mechanical stokers, the engine-rooms manned by Indian personnel under British officers.

One reason which may be advanced against such engine installations is an alleged difficulty in finding marine engineers capable of looking after the higher-class machinery made necessary for most economical working. The answer to this problem will be found to be the adequate remuneration of the personnel involved. There is no dearth of well-educated engineers these days, but there is but little inducement to them to seek a seagoing life, except for a short period of education. To enable advantage to be taken of the most recent economies that modern engineering can show, adequate payment must be made to the relatively small staffs involved, and better living conditions provided on board. The small sums so spent will amply recoup the owners in the long run.

ALUMINIUM WORKS FOR N.S.W.—Plans are well advanced for establishing in Sydney a sheet aluminium industry. The Australian Aluminium Company, with a capital of £A1,000,000, in which the British Aluminium Company and Aluminium, Ltd., of Canada are shareholders, has erected a large factory, in which for the time being aluminium wares will be produced from imported ingots in various structural shapes.

The New Battleship H.M.S. "Prince of Wales"

IN the accompanying engraving we illustrate the new battleship H.M.S. "Prince of Wales," which is now in service with the fleet. She is a sister ship to "King George V" and the second ship of her class. Three more ships are yet to come, the "Duke of York," "Jellicoe" and "Beatty," all of the 1937 naval programme. They were launched some months after the first two battleships and are due for completion this year, work on them being well advanced. All of these ships have a displacement of 35,000 tons, the principal dimensions being length, 739ft. 8in.; beam, 103ft.; and draught, 27ft. 8in. The armament comprises ten 14in. guns, sixteen 5·25in. guns, four multiple pompoms, besides several smaller guns. Four aircraft are carried, two launching catapults being provided. It is officially stated that the armouring of these ships includes enhanced defence against air attack, which embodies an improved distribution of deck and side armour, more elaborate sub-division and an improved system of underwater protection. According to "Jane's Fighting Ships," unofficial reports give the weight of armour as over 14,000 tons and its water line thickness as 16in. The "Prince of Wales" was laid down on January 1st, 1937, at the Birkenhead yard of Cammell Laird and Co., Ltd. Her propelling machinery comprises a quadruple-screw arrangement of Parsons geared turbines taking steam from Admiralty three-drum oil-fired boilers. The designed output of the turbines is about 152,000 S.H.P., corresponding to a speed of over 30 knots. Improvements in boiler design have reduced the boiler weights in these ships by about 15 per cent. as compared with the earlier battleships "Nelson" and "Rodney."

BOOKS RECEIVED

The "Motor Ship" Reference Book for 1941. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 7s. 6d. net.

Aircraft Engines. Vol. 2. By A. W. Judge. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 30s. net.

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The Engineer

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PRODUCTION AND ACQUISITION OF AIRCRAFT

THE statement on the production and acquisition of aircraft, made by Lord Beaverbrook in the House of Lords on April 23rd, has, for the most part, been accepted as a comforting pronouncement concerning the present position of aircraft and aero-engine production in this country and of the supply of aeronautical equipment from the United States. A typical comment upon it was that of one leading London newspaper, which described it as "a reassuring statement, which will be received with the greatest satisfaction by the public." If, however, the public relies solely on the reports of the statement as summarised in the daily Press, it will certainly not find it very easy to recognise the feeling of satisfaction and reassurance which it is alleged to have manifested. The necessity for compression and the difficulties of newspaper production in prevailing circumstances may be advanced as good excuses for the manner in which the statement was reported, but the fact remains that to many readers of the daily Press the statement, far from being reassuring and satisfactory, must have appeared disjointed, interspersed with irrelevances and incomprehensible in places. *The Times*, for example, reported Lord Beaverbrook as claiming that his Ministry had launched three fighters, the "Beaufort," the "Fulmer" (*sic*) and the "Whirlwind." The Bristol "Beaufort," however, is not a fighter, but primarily a bomber. Further, it is a pre-war machine. It was described and illustrated in our issue of June 9th, 1939, long before the Ministry of Aircraft Production came into being. In actual fact, Lord Beaverbrook claimed for his Ministry, not the "Beaufort," but the "Beaufighter." In the *Daily Telegraph's* report of the statement the following passage occurs:—"In the last day or two we had received a message from Washington that it was the intention of the American Government to produce the Sabre engine for us and we were producing the Packard-Merlin over here." This is a very complete inversion of what Lord Beaverbrook really said. It is the intention of the American Government to produce the Sabre engine in America *for its own account*. The Packard-Merlin, the name given to the Rolls-Royce Merlin engines produced in America by the Packard Company under a contract placed some time ago with that company by the Ministry of Aircraft Production, will shortly be in production *over there*. These may be small errors of reporting, excusable, as we have said, in the prevailing circumstances; but, together with others, they are bound to produce a very considerable volume of mystification and misapprehension in the reader's mind concerning the true position as revealed by Lord Beaverbrook.

Relying on the official report of the statement, we can say that it was a clear and connected account of the position as to the production and acquisition of aircraft and aero-engines, containing information much of which was reassuring, but boldly facing the facts when they were not altogether satisfactory. We will endeavour to present an undistorted summary of it in order that our readers at least may not be misled as to what Lord Beaverbrook said. It should, in the first place, be understood that the statement was made in reply to a lengthy criticism from Lord Sempill of the manner in which the Ministry of Aircraft Production's programme for the supply of aircraft, equipment and spares from the United States was being fulfilled. Included in it also was a reply to an inquiry from Viscount Samuel for information on the supply of aircraft generally, whether from our own factories or from overseas. In a general way Lord Sempill suggested that there had been lack of co-operation between our authorities and American designers of aircraft and aero-engines, with the result that insufficient attention had been given to the important duty of uniting our operational experience with American designing skill. In his reply Lord Beaverbrook said that with the object of assisting American designers samples of practically all our operational types of aircraft had been sent across to the United States. Delays in the delivery of American aircraft were not serious. Some manufacturers were up to time and some even ahead of it. Already nearly a thousand assembled American and Canadian aircraft had been handed over to the Royal Air Force. He admitted, however, that there had been a steady drain on our shipments by sea of American aircraft as a result of losses in convoy, but the flow of machines from the factories was now increasing so rapidly that in spite of those losses the anticipated supply would be realised. The system of ferrying aircraft across the Atlantic under their own power had been in operation since last autumn and had been continued throughout the winter months. The Germans had said that our losses on the ferrying service had been so severe that we were about to give up the plan. In actual fact we had so far lost only one aeroplane on the ferrying service—that in which Sir Frederick Banting lost his life. The service would not only be continued, but would be extended and it was quite a possibility that before long we would be ferrying across not only bombers, but fighters. Lord Sempill referred to certain difficulties experienced on this side with American aero-engines. It is not quite clear from the report of his remarks what these difficulties were or are. It may, however, be inferred that in part at least they have consisted of a lack of service facilities for the salvage of damaged engines. Lord Beaverbrook admitted that there had been difficulties with American air-cooled engines, but claimed that they had now been overcome.

Turning to the production of aircraft and aero-engines in this country, Lord Beaverbrook gave an indication of the manner in which we had prevented the enemy's bombing attacks on our aeronautical factories from bringing their output to a standstill. Dispersal, he said, had been carried out on a very daring basis and at heavy expense. He instanced the case of one plant, which used to occupy a single site, but which was now represented by forty-two separate centres of production scattered over five counties. Duplicate production resources reduced the chance of the organisation being interrupted by the bombing of some of the centres. Dispersal undoubtedly affected output, sometimes considerably, but the system had worked out very satisfactorily. On some occasions the Germans claimed to have inflicted immense damage on an aircraft factory when actually the factory no longer occupied the bombed site. The dispersal system had also been applied to the plants supplying the raw materials of the aircraft and aero-engine industry. He admitted that difficulties had been encountered in the fabrication of those raw materials and in the supply of the tools and presses used in their production. The position was now somewhat improved in that respect. The Controller of Fabrication of Raw Materials had assured him that no fighter aircraft were now being held up by reason of a shortage of steel, light alloys, forgings and stampings. He had circularised that statement to the aircraft factories, only two of which failed to agree with it. Difficulties had also been met with in the supply of equipment, such as guns, radio apparatus and navigational devices. At one time the insufficiency in the supply of such equipment, particularly in the supply of guns, had prevented aircraft from being passed into immediate operation. Equipment shortages still existed, but they could be overcome. The repair and salvage of aircraft and aero-engines had been developed on a large scale. The aluminium salvaged from various sources had been sufficient to yield one month's supply of the material.

Concluding his survey, Lord Beaverbrook said that in February we produced more bombers and fighters of the operational type than ever before. In March we surpassed the February record. The output in March this year was actually two and a-half times the production in March last year. Our reserves, he disclosed, now amounted to about 100 per cent. in the case of the five principal operational types, but his Ministry was aiming at a reserve of two or even three hundred per cent. In spite of the aid coming from America, our own production must always be of first importance. The very fact that the United States was giving us freely and generously of its assets should increase our determination to develop our own resources to the uttermost.

Lord Beaverbrook's words, when correctly reported, speak so ably for themselves that comment upon them seems almost superfluous. He has been criticised by one leading aeronautical writer for laying too much emphasis on the purely numerical aspect of our growing air strength. When he speaks of our March output being a record he doubtlessly means a record in numbers of aircraft produced. We are in agreement with the view that such a basis of assessing our output may be misleading unless we know the composition of the output, that is to say, how many light aircraft, of the trainer and fighter class, and how many heavy aircraft, of the bomber and flying-boat type, were included in it. Even with this additional information, however, we would not be fully in a position to assess the growth in our air strength represented by the excess of our production over our losses. We must, in order to form a sound judgment, know something of the quality of the machines and engines produced. On this score there is, we think, sufficient evidence in Lord Beaverbrook's statement and from other sources that not only is the output of aircraft increasing, but that it is advancing in the quality of the machines and engines produced. The Minister himself told us a little about our new engines, the Napier "Sabre" and the Rolls-Royce 2000 H.P. "Vulture." According to American sources, our four-engined Short "Stirling" bomber has a wing span of 127½ft., a range of 3000 miles and a speed of over 330 miles an hour. One of our other new bombers, the "Manchester," has two "Vulture" engines, a span of 90ft. and a speed of 325 miles an

hour. The speeds of these large machines, it will be noted, are equal to that of the "Hurricane" fighters which took part in the Battle of Britain last autumn. Among our new fighters is the Hawker "Tornado," which is credited with a speed of 425 miles an hour and has an engine of 2000 H.P. The Hawker "Typhoon" would appear to be an even more formidable fighter. It is stated to be equipped with a "Sabre" engine of 2400 H.P. and to have a speed of well over 400 miles an hour. It has a mixed armament of cannon and machine guns and is said to be capable of operating at a height of 40,000ft. These facts and figures indicate unmistakably that our output is not only increasing in numbers, but is also advancing in quality. On the whole, therefore, while there are aspects of the situation which are less than completely satisfactory, we can rest assured that, in the words of Sir Archibald Sinclair, when introducing the Air Estimates recently in the House of Commons, "unless Hitler has up his sleeve a more effective secret weapon than any he has yet managed to produce, our technical superiority, with the moral superiority which accompanies it, will certainly be maintained." Our ability to achieve aerial supremacy would appear to be as undoubted as our determination.

Obituary

PROFESSOR CHARLES GILBERT CULLIS

MINING engineers and metallurgists in many parts of the world will learn with regret of the death of Professor C. Gilbert Cullis, which took place at Hindhead, Surrey, on Sunday last, in his seventieth year. For six years from 1930, he was Professor of Mining Geology at the Royal School of Mines, South Kensington. Since 1937 he had been Emeritus Professor, and from 1937 to 1938 he served as President of the Institution of Mining and Metallurgy. Dr. Cullis came of a Gloucester family, and received his education at King Edward's and Masons College, Birmingham. From 1892 to 1914 he was a Demonstrator and Assistant Professor of Geology at the Royal College of Science. He was a Doctor of Science of the University of London. In 1914 he was appointed Professor of Economic Mineralogy at the Imperial College of Science and Technology, South Kensington, and he held that office till 1930, when he became Professor of Mining Geology. After his retirement Dr. Cullis did much for the Institution of Mining and Metallurgy during his term of office as President. He was a well-known writer on problems relating to mining geology and mineralogy, and among publications we may recall his report on the World's Production of Silver for the Indian Currency Committee of 1919, and his report on the Copper Deposits of Cyprus for the Colonial Office in 1922. In 1924 Dr. Cullis prepared another report on the Geology and Mineral Resources of Cyprus. He was a valued member of the Non-ferrous Metallic Ores Committee of the Ministry of Supply. His death at the age of seventy will be mourned by a wide circle of past students and friends.

Sixty Years Ago

THE LOSS OF THE "DOTEREL"

ON April 26th, 1881, H.M.S. "Doterel" was destroyed by an explosion while lying off Sandy Point in the Straits of Magellan. Eight officers and 133 men lost their lives. There were only twelve survivors, one of whom was the ship's captain, Commander Evans. The "Doterel" was a small cruiser of 1140 tons displacement and was on her first voyage. She was built of wood planking in two thicknesses secured to iron frames. Her engines were compound and indicated 950 H.P., but she was rigged as a barque and relied almost always on her sails for propulsion. She had three boilers and carried 140 tons of coal. Commander Evans reported that shortly after 9.30 a.m., while he was in his after cabin, he heard a report resembling the discharge of a gun. Looking forward he saw that the ship's side was burst open and that the upper deck had been forced up and twisted. Water was rushing in and the ship was heeling over. Thirty seconds or so later there was another and more violent explosion. Smoke and *débris* were thrown up and the ship began to sink rapidly. He jumped into the water and was rescued by boats from the shore. From the time of the first explosion until the ship sank was not more than three minutes. Commander Evans suggested that the first explosion was caused either by the bursting of one of the boilers or by the ignition of an accumulation of gas in one of the bunkers or by the spontaneous combustion of the coal. He felt no doubt that the second explosion came from the contents of the forward magazine. . . . We recorded the disaster in our issue of May 6th, 1881, and in our issue of June 3rd of that year we published Commander Evans' report and commented upon it. Various theories to account for the disaster were circulated. One suggested that a torpedo had exploded in the ship's magazine. Another hinted that the ship had been destroyed by a mine laid by Chilian or Peruvian forces during the recent war. Another, not without plausibility we said, attributed the disaster to an infernal machine hidden in the coal by Fenians. Our own view was that the most probable cause lay in the ignition of an accumulation of gas in one of the bunkers. We found reason to reject the suggestion that the forward magazine blew up and held that gas ignition accounted for both explosions. The Court of Inquiry which was appointed to investigate the disaster dismissed, on the evidence of divers, the suggestion that the boilers had exploded. It held that the first explosion came from an accumulation of gas in one of the bunkers and that the flame from that explosion had found its way into the forward magazine and detonated the 5 tons of gunpowder stored therein.

Luncheons of the Week

INSTITUTE OF WELDING.—The Institute of Welding held a luncheon at Grosvenor House, London, on Wednesday, April 23rd, when Sir William J. Larke presided over a large company of members and guests. In proposing the toast of "The Guests," Sir William referred to the research work undertaken by the Institute since the International Welding Congress in 1935, and said that that work was still going on almost as normally as in peacetime. He emphasised the fact that one responsibility of the present time was to ensure that science and technology were rapidly applied in the war effort, and in that the progress of welding could take an important part. Dr. H. J. Gough, Director of Scientific Research, Ministry of Supply, replied to the toast, and gave some typical examples revealing the research work being carried out by the Institute. He then spoke of some of the more general aspects of welded fabrication, particularly in relation to the war effort, and said that if consideration was given to the applications for which welded construction had been proved satisfactory and economical, it would be found that 15 per cent. only of the work to be done was actually welded. At a time when increased production was such an urgent need, he suggested that all responsible for production should examine carefully, and with an open mind, whether greater use could not be made of fabricated construction. It was satisfactory to note that the Ministry of Labour had reorganised its scheme of training welders on lines suggested by the Institute, making it possible to produce a greater number of welders to a standard of training in accordance with present needs. As examples of real advantage in the national effort, Dr. Gough mentioned the saving of weight by welded construction in portable hangars, military bridging equipment, light armoured cars, bombs and shells, anti-aircraft gun platforms and railway tank wagons. In the field of shipbuilding it had been shown that a saving of weight of 10 to 20 per cent. could be effected by fabricated construction, and the Admiralty's progressive policy in this matter was to be appreciated. He was glad to be able to state that the Ministry of Supply, appreciating the importance of the use of welding in the production of munitions of all kinds, had called for the help of the Institute and the collaboration of the industry to ensure that welding should be used to the best advantage in the war effort.

INSTITUTION OF STRUCTURAL ENGINEERS.—The Institution of Structural Engineers held a luncheon at the Dorchester Hotel, London, on Friday, April 25th, when the principal guest was the Right Hon. Arthur Greenwood, Minister without Portfolio. Mr. J. F. Butter, President of the Institution, was in the chair. After the loyal toasts, Mr. Greenwood proposed "The Institution" and spoke mainly of the present war position. He referred to the stern months that lie ahead and said that we must be able to give the enemy larger and still larger doses of his own medicine. Still greater production of tanks, aeroplanes, ships and armaments of all kinds would be the instruments of our victory. Afterwards, said Mr. Greenwood, would come the time of reconstruction, and in that structural engineers would play an important part, and the experience, knowledge and good will of bodies of responsible people like the Institution would be vitally necessary. The President acknowledged the toast, after which Mr. W. K. Wallace, President-elect, proposed the health of "The Guests," and Mr. George Hicks, Parliamentary Secretary, Ministry of Works and Buildings, responded.

THE JUNIOR INSTITUTION OF ENGINEERS.—A large number of members and guests attended the annual luncheon of the Junior Institution of Engineers at the Holborn Restaurant on Saturday, April 26th, and notwithstanding the war conditions the high spirits always evident at the functions of this Institution were as noticeable as ever. Well-chosen humour in the speeches following the luncheon did much to modify the serious notes which naturally came in at such a time. In proposing the toast of "The Institution," Sir Leopold H. Savile, President, Institution of Civil Engineers, stressed its influence, much of which resulted from the choice of Presidents, and congratulated its executives on the way the work of the Institution had been carried on under the difficult conditions since the outbreak of war. Following a response by Mr. J. W. Stenson, a toast, "Scientific Industrial Research and National Service," was proposed by Sir William Bragg, a Vice-President of the Institution. Sir William pointed out that, like industry, science had to undergo radical changes to adapt itself to war conditions, and although much still remained to be done in that respect, scientific research was now recognised as a great national asset. He emphasised the vital necessity of giving research workers facilities to get into direct contact with the actual problems and conditions involved in warfare, as it was obvious that no apparatus or weapon was foolproof when designed, and the best man to see faults and make modifications was the scientist. The efficiency of our military aircraft was the outcome of the scientist's work, and with the greatly increasing performances of those machines scientific research workers were now concerning themselves with selection and training of men able to stand up to the great physical strains involved in their manœuvring. He said that scientific research workers not only needed to have technical ability, but were also required to be able to lead and impress men in industry; in other words, the scientist of the present day had to combine technical knowledge with vision and personality. This toast was acknowledged by the President of the Institution, Lord Falmouth, who spoke of the debt of gratitude science owed to Sir William. He pointed out the value of co-operative research and said that, although occasionally the designs of scientists left a certain amount to be desired when their apparatus came to be made, he was glad to hear that the matter was now receiving closer attention. In a few well-chosen words Mr. N. L. Ablett proposed the health of "The Guests" and suitable responses were made by Sir Harold Hartley and Mr. J. R. Beard. The latter spoke of post-war planning and the necessity for all engineers to speak with one voice in its decisions.

INSTITUTION OF CIVIL ENGINEERS.—The Institution of Civil Engineers luncheon took place at Grosvenor House, London, on Wednesday, April 30th, when the principal guests were Lord Reith, P.C., Minister of Works and Buildings, and Captain A. U. M. Hudson, M.P., Civil Lord of the Admiralty. The President of the Institution, Sir Leopold H. Savile, K.C.B., was in the chair. After the loyal toast, the President said that he was permitted to give news of the successful evacuation of 75 per cent. of our forces from Greece, and proposed the health of the Prime Minister. Lord Reith proposed the toast of "The Institution," and in a speech containing many light touches gave an account of the work and responsibilities of the Ministry of Works and Buildings. As well as attending to the maintenance of some 14,000 Government buildings throughout the country, the construction of new factories, storage accommodation, landing grounds, and training centres, claimed the attention of the Ministry. Under a new system of allocation of building work, Lord Reith continued, the more urgent construction works will be undertaken to ensure speedy completion demanded by the war effort. After paying tribute to the work of General Appleyard's department, which is concerned with first-aid repairs to air-raid damaged cities and towns, the Minister remarked that post-war planning had also to be considered. He was sure that civil engineers, always so careful in planning their own works, would welcome a scheme of co-ordination and ordered planning for the future. In acknowledging the toast, the President spoke of the work of the Institution during the past session, and referred with satisfaction to the setting up by the Government of the Advisory Committee of Engineers, which had been announced that morning. Professor C. E. Inglis, a Vice-President, proposed the health of "The Guests," and it was acknowledged by Captain A. U. M. Hudson.

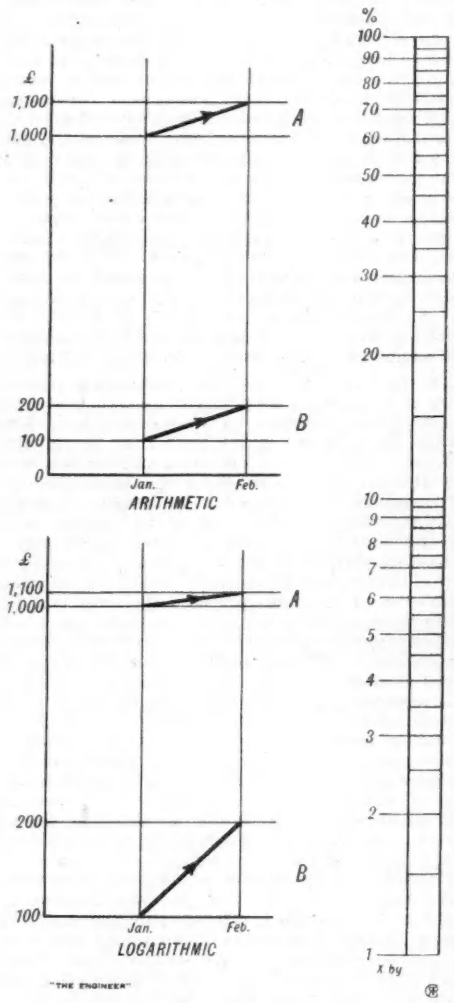
DEEPENING A CHANNEL.—To provide adequate depth for American Navy ships passing along the Delaware River from the Philadelphia Navy Yard to the sea, United States engineers are deepening the present 35ft. channel to 40ft. The work involves the removal of about 30,000,000 cubic yards of sand, gravel, clay and mud and 165,000 cubic yards of ledge rock, which covers a 4-mile stretch of channel from near Eddystone, Pa., to a point off Marcus Hook, Pa. The rock drilling is being done by specially equipped boats used on the Great Lakes. A single boat can drill sixteen holes on 6ft. centres at a single set-up, and the drilling machines are steam hammer operated. The drills are 3in. diameter hollow steel bars, 59ft. long, with detachable bits. Facilities provide for cleaning drill holes by 100 lb. of air pressure or 175 lb. of water pressure. Steam for the drilling operation is supplied by two 150 lb. per square inch Scotch marine boilers.

Two Aids to the Use of Logarithmic Chart Paper

By A. W. SWAN

Effect of Visual Habits on Planning Charts

CHARTS convey impressions to the eye, and are entirely pictorial in their message. It is therefore necessary when planning charts to bear constantly in mind that the present-day educated person has unconsciously acquired a large number of optical habits which sway his visual judgments. The extent of these habits is illustrated by photography. We look, for instance, at a black and white photograph of a landscape and consider it "natural." It is, however, a rendering into a series of greys of an immense range of colours, and we only find it natural because we have become accustomed to a particular set of conventions. A photograph of the same subject taken twenty years ago on an orthochromatic plate would look quite unnatural to us to-day, with very dark trees and with blue sky rendered as white; but it looked natural to the photographer



FIGS. 1, 2 AND 3

of the time. As in photography, it is possible by selecting a lens of particular focal length to alter the apparent perspective, and by selecting a lens screen to render blue sky white, grey, or black, so it is possible in designing charts to take advantage of optical habits, and by the use of suitable chart paper and scales, not merely to present the facts in the simplest and clearest way, but to select the order of emphasis.

The above general remarks are of practical importance when charts are being designed to compare sales, outputs, &c. If outputs are being charted monthly for two departments, and those of A move in a month from £1000 to £1100, and those of B from £100 to £200, there are two aspects, either of which, but not both, can be emphasised: (1) The actual gain, £100 for A and £100 for B, or (2) the percentage gain, 10 per cent. for A and 100 per cent. for B.

From Fig. 1, which shows the information charted on ordinary arithmetic (equal division) paper, it is clear that the emphasis is on the equal gain in pounds sterling, and the visual impression of comparative performance is entirely erroneous. Although the change in ratio from "10 to 1" (£1000 to £100) to "5½ to 1" (£1100 to £200), and the fact that B is actually doing far better than A, could be deduced from the chart, the visual impression is, in fact, the misleading one that A and B are behaving similarly. Optically, this is due to the habit we have all assumed that equal slopes indicate equal rates of gain or loss. On arithmetic chart paper a slope has different meanings according to its height from the base, and the same slope means a 100 per cent. gain at 100 and 10 per cent. gain at 1000. What is wanted, therefore, for comparisons is a chart paper on which a slope is always a measure of the same percentage gain or loss.

Special Features of Logarithmic Chart Paper

Logarithmic chart paper provides the solution to the problem. Since on logarithmic chart paper a distance represents a difference of logarithms and therefore the ratio of the numbers represented by these logarithms, the following useful principles follow:—

(1) So long as the ratio remains the same, two curves will remain the same distance apart.

(2) If the ratio decreases, *e.g.*, if the lower curve gains more *pro rata* than the upper, the lower line will rise more steeply than the upper and the distance between the two will decrease.

(3) If the ratio increases, the upper line will rise more steeply than the lower, and the distance between the two will increase.

(4) A slope is a direct measure of percentage gain or loss, however high or low on the scale it may be.

The practical implications of the above are extremely important and make logarithmic paper ideal for comparison. For example, Fig. 2, drawn on logarithmic paper, shows departments A and B as before, but the steeper slope of B conveys immediately the impression that B is gaining more rapidly than A, which is the point to be emphasised. Logarithmic paper is ideal, therefore, for comparison of rates and should always be used when the main purpose is comparison, particularly of large and small units, *e.g.*, sales or production of a large combine and one unit, population changes in an urban and rural district, &c.

Rule for Measuring Ratios

The normal way of using charts on logarithmic paper is to form general impressions from the relative positions and slopes of the lines. When this is done, the unconscious and subconscious optical habits affect the judgment, but, fortunately, to advantage, so that, as explained above, the visual estimation of comparison is reasonably accurate. It is possible, however, by very simple means, to go much further than general impressions, and when using logarithmic chart paper to measure quickly and accurately:

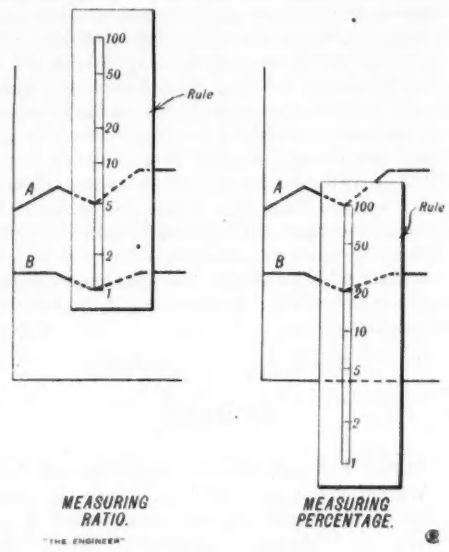
(1) The ratio of the quantities shown on any two or more curves at any given date (assuming time to be the horizontal scale).

(2) The relation in the form of percentage between the quantities shown by a group of curves representing components and the combined total.

Both (1) and (2) can be measured quickly at any part of the chart by means of the simple transparent rule illustrated in Fig. 3. In laying out the scales on logarithmic paper, it is necessary to bear in mind that from the fundamental nature of the logarithmic scale, one "cycle" can represent "1 to 10," "10 to 100," "100 to 1000," &c. If, therefore, the chart is to deal with quantities ranging from, say, 5 to 50, the curves will cross from the "1 to 10" cycle to the "10 to 100" cycle, and it will be necessary to use what is known as "2 cycle" paper. Similarly, if the quantities range from 50 to 5000, "3 cycle" paper will be needed, and so on. The complication is more apparent than real, and there is no difficulty in practice. For general purposes, the most useful paper is the 2 cycle or 3 cycle. The method of constructing the rule is to draw on tracing linen a replica of two cycles in the manner shown, and to scale off from 1 to 10 on the lower cycle, and 10 to 100 on the upper cycle.

When the ratio of two quantities is desired, the "1" at the bottom of the rule is placed over the lower line at the desired point, and the ratio read off where the upper line passes under the rule. When measuring percentages, the "100" at the top of the rule is placed over the upper line at the desired point, and the percentage read off where the lower line passes under the rule.

The two methods of use are illustrated in Figs. 4

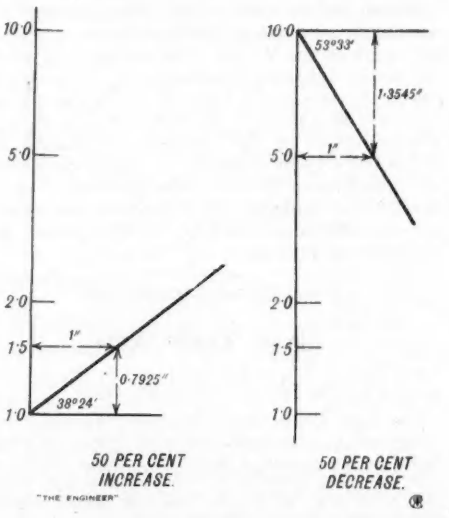


FIGS. 4 AND 5

and 5: (1) In Fig. 4 it is desired to know the ratio of A to B at a given time. The "1" of the rule is placed over B on the appropriate vertical line, and it is seen that A is 5 times B at that time. (2) For percentage (Fig. 5) the rule is moved downward over the same vertical line until the "100" on the rule is over A; it is then seen that B is 20 per cent. of A (20 per cent. $= \frac{20}{100} = \frac{1}{5}$; the ratio is measured by the same vertical distance on logarithmic paper, however expressed, and however high or low on the paper).

Calculator for Percentage Gain or Loss

On the lines of the above rule to measure ratios or percentages it is possible to construct another



FIGS. 6 AND 7

simple transparent measuring device to take fuller advantage of another very useful characteristic of logarithmic paper. In general, comparisons of sales, output, changes of population, are required on a time basis—once an hour, day, week, month, &c. For this type of chart it is customary to use what is known as semi-logarithmic chart paper, logarithmic for the vertical scale, arithmetic for the horizontal time scale. Since a vertical distance on the logarithmic scale represents a definite ratio, *e.g.*, a definite gain or loss, if the horizontal scale is uniform, a rise from, say, 100 to 110 over one unit of time, say, a week, will represent a gain of 10 per cent. in that time

and will be parallel to a rise from 1000 to 1100, 10,000 to 11,000, &c., in the same period. In other words, the same slope upwards or downwards, wherever placed, always represents the same percentage gain or loss. It is therefore possible to construct a fan measuring device on which the slopes represent 10, 20, 30 per cent., &c., gain or loss (Fig. 8).

The method of constructing the fan calculator is to take each slope in turn and ascertain the angle by measuring its tangent. As an example, take the "50 per cent. increase per month" on the fan calculator illustrated. The horizontal scale has been fixed arbitrarily at 1·0″ and the "adjacent side" is therefore known for all slopes to be 1·0″. The vertical distance for a 50 per cent. increase will be that from the "1" marking to the "1·5" marking, and it is necessary to calculate this distance in inches. A complete cycle, *e.g.*, "1" to "10," is on this particular chart paper equal (say) to 4·5″. As the paper is laid out with distances

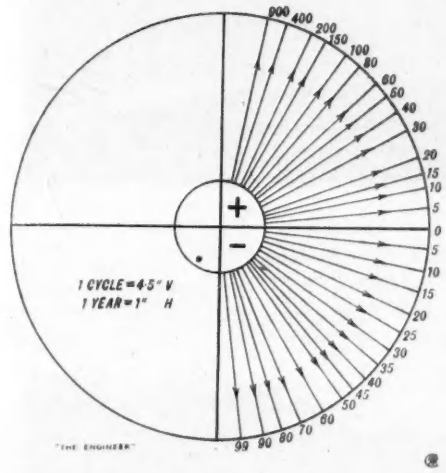


FIG. 8

proportional to the logarithms of numbers, the distance from "1" to "1·5" on the vertical scale will be $\frac{\log 1{\cdot}5}{\log 10}\times 4{\cdot}5''=\frac{0{\cdot}1761\times 4{\cdot}5''}{1{\cdot}0}=0{\cdot}7925''$. The "opposite side" of the tangent, the distance from 0·1 to 1·5, is therefore 0·7925″, and we can calculate the tangent. If we call the angle α, $\tan\alpha=\frac{0{\cdot}7925}{1{\cdot}0}=0{\cdot}7925''$, which is the tangent of 38° 24′ (Fig. 6). The angle corresponding to any other percentage increase can be similarly calculated. It should be noted as a pitfall to be avoided, that for a given percentage the equivalent number whose logarithm is used for calculation purposes is the percentage plus 100, *e.g.*, the equivalent number for 100 per cent. increase is 100+100=200.

It might be thought that having calculated the angles for percentage increases, it would only be necessary to draw the same angles downward to make the "decrease" section of the fan. This, however, is not the case, for the reason that whereas a number may increase, 100, 500, 10,000 per cent., &c., *ad infinitum*, its maximum decrease, leaving out negative numbers, is 100 per cent. It follows that the angle for a given percentage decrease will always be steeper than the angle for the same percentage increase. For example, if 100 increases to 150, the increase is $\frac{50}{100}=50$ per cent.; but, if now 150 drops again to 100, the decrease is $\frac{50}{150}=33\frac{1}{3}$ per cent. Thus the angle of rise for 50 per cent. increase and the angle for $33\frac{1}{3}$ per cent. decrease are the same.

The method of measuring the angle for the "decrease" section of the fan is similar to that for the "increase" section with the addition of another step. As before, the horizontal distance "adjacent side" is fixed at 1·0″. Also, as before, it is necessary to measure the vertical distance, "opposite side," which is, in fact, the distance downward from "10" to the particular marking, *e.g.*, "5." In this case, however, the distance (for percentages as far as 90 per cent. decrease, the first cycle) is obtained by difference. For example, for a decrease of 50 per cent. the equivalent number is 5, log 5=0·6990. Converted to the scale of 1 cycle=4·5″ from 10 to 1, the position of the 5 marking, upwards from 1, is 0·6990×4·5″=3·1455″. The distance downward from 10 is 4·5″−3·1455=1·3545″. If we call the angle for 50 per cent. decrease β, $\tan\beta=\frac{1{\cdot}3545}{1{\cdot}0}=1{\cdot}3545$; therefore $\beta=53°\ 33'$ (Fig. 7).

The angles for other decreases as far as 90 per cent. can be calculated similarly. For decreases from 90 to 99 per cent., 4·5″ is added to the distance downward from 10, from 99 to 99·9, 9″ is added, and so on. The fan is simple to use. When a percentage increase or decrease is desired all that is necessary is to place the centre of the circle over the point of departure and read the increase or decrease per cent. required.

Single-Purpose Machine Tools

(*By a Correspondent*)

THE versatility of the engine lathe has often been demonstrated, and many engineers have prided themselves on the way in which they have circumvented difficulties by temporarily using one of their lathes as a milling machine or planer. For the odd job that comes along in a general engineering workshop this ingenuity is commendable, but when it is a case of planning for mass production only the best machine tool lay-out should be tolerated. If this statement can be taken as axiomatic, the question at once arises as to the reason for such a variety of tools being employed on the mass production of munitions, a question easily asked, but not so readily answered.

Can the expensive turret lathe justify itself for such work as shell machining? I am inclined categorically to affirm that in this particular instance it cannot. Why, then, are such machines used for the work? Is the works manager averse from introducing into his machine shop equipment the simple contraption on which he looks askance as unworthy of the designation of a machine tool? Other questions suggest themselves, but it will be well to leave them and to examine the general position, bearing in mind that in the production of munitions machining operations may be broadly divided into two categories: (1) those that can best be done on costly machines of the turret or capstan type, and (2) those that can readily be broken down into simple operations, easily separated.

Let us consider a mass production job that is much to the fore at the present time, the machining of shell bodies from rough forgings, and analyse the relative advantages of using a recognised machine of the turret lathe type for most of the operations, or a series of single-purpose machines, each of which caters for but one operation. Some of the work would be called "hogging" by the shopman, while other would be light, and accordingly if one machine is to undertake a number of different duties it must be rigid enough for the most exacting of its varied tasks. On the other hand, when single-purpose machines are used, the rougher will be of heavy construction, with heavy bearings, and the like, whereas the machine for light turning will be proportionately lighter in build.

Let me set out the principal advantages of the single-purpose machine as a definite challenge to the claims of the turret lathe exponent. It is simpler to produce, and the work of its manufacture can be entrusted to firms who have little or no experience in the building of standard machine tools, a very important consideration at a time when the recognised machine tool trade is loaded to capacity with orders for its normal products. During the last war makers of textile machinery built single-purpose machines for their own use when they undertook munition work, and even sold them to other firms at a remarkably low price. It is an open secret that a simple thread milling machine for screwing the fuse hole of a shell, and built by a firm of agricultural engineers, was so efficient that some of them were still at work in the Royal Arsenal, of all places, up to the time of the present conflict. There, again, the fact that there should be no valuable tool steel lying idle unnecessarily is an important consideration when tool steel requirements are phenomenal; the cutting tool on the single-purpose machine is "going to it" for a maximum number of hours, while that on the turret lathe is perforce idle for a large percentage of its time. In war conditions it is imperative to make work as simple as possible with a view to the fullest advantage being taken of dilution of labour, and here the single-purpose machine scores heavily. A girl new to the work realises the simple character of the machine she is asked to operate, and readily settles down to the work with very little training being required, whereas the turret lathe strikes terror to the novice as it looks a terribly complicated affair.

Again, by concentrating on one job and one job alone, a degree of efficiency is developed which has to be seen to be believed. The fact that female operators are quite complacent about working day in and day out on the same operation has been well established. Accordingly, speed and cheapness of the initial equipment, economy in tool steel, easy manipulation after a very short training period, coupled with each operator becoming an expert in his or her particular sphere, thereby ensuring rapid and satisfactory work, present a case which it is hard to beat.

But, argues the rival school, think of your handling problems, and then meditate upon the increased number of machine tools you will need to employ. I agree there are handling problems, but these arise only to be solved, and with properly constructed runways, with slides to the machine tool centres, so that the very centres themselves may be used for raising the shell, or by a number of other simple expedients, the problem ceases to be a problem, and the loss of time is infinitesimal, while it should not be forgotten that the turret worker cannot be as near the actual job and so has to make additional movements.

If it be allowed that the use of turret lathes may reduce the actual number of machines for a given output, it is seriously suggested that this is by no means an unmixed blessing. Even the best behaved of machines break down at times, and while with the turret lathe out of commission a series of operations are arrested, with the breakdown of the single-purpose tool only one operation is lost. When everything is taken into account it is surprising that mass producers have not more wholeheartedly adopted the single-purpose tool.

If they would but do so they would enable the machine tool industry the better to concentrate on their standard turret, capstan, and high-duty lathes which are so essential to the national effort.

After this the logical sequence would appear to be to introduce a belt system of manufacture, with operations reduced to a standard number of minutes, as has been so successfully employed in motor-car assembly. The even flow of output which would result is greatly in its favour, and it is suggested that now is the time for a few progressive engineers to experiment and evolve a more satisfactory scheme for mass production. It is a study that justifies both time and thought.

THE BEAMA ANNUAL GENERAL MEETING

THE thirtieth annual general meeting of the British Electrical and Allied Manufacturers' Association was held in London on Thursday, April 17th. In the course of his address, the Chairman, Mr. J. L. Wilson, referring to the brevity of this year's report, said that it was a measure of the shortage of paper and not of any reduced activities on the part of the Association. Two main electrical export groups, he continued, were formed, under the auspices of the BEAMA, to deal with the export problems first of the heavy apparatus, under the chairmanship of Mr. Watlington, and then of the lighter apparatus, under the chairmanship of Mr. Rodgers. During the year signal service was rendered by the special department set up by those two groups to secure the necessary materials to fulfil export contracts. The work of the Contract Conditions Committee had been of a most complicated character, such as dealing with the problems of equitable compensation to the manufacturer for the ever-increasing costs of labour and materials, the conditions for carrying out war damage reconstruction work, and the incidence of war risks insurance. The Purchase Tax Committee was a newly formed body of the BEAMA and other electrical associations to deal with the intricacies of the Purchase Tax and to assist the Customs authorities in the equitable administration of the Act. The technical committees had continued to carry out their work in spite of the difficulties of holding meetings. Mr. Wilson also referred to the formation during the past year of associations dealing with refrigeration and with X-ray equipment and also a section dealing with arc welding electrodes. At a subsequent meeting of the new Council, Mr. L. W. Smith—managing director, Elliott Brothers (London), Ltd.—and Mr. J. L. Wilson—director, The British Thomson-Houston Company, Ltd.—were unanimously elected Chairman and Vice-President respectively for the next session.

BAND CONVEYORS AND AERIAL ROPEWAY AT A BRICKWORKS

MAVOR AND COULSON, LTD., GLASGOW, AND R. WHITE AND SONS, WIDNES, ENGINEERS

(*For description see opposite page*)

FIG. 1—MAIN AND FACE CONVEYORS

FIG. 2—CONNECTION BETWEEN MAIN CONVEYOR AND ROPEWAY

FIG. 3—ANGLE STATION

FIG. 4—RETURN TERMINAL STATION

Aerial Ropeway and Band Conveyors at a Brickworks

A QUESTION of importance to brick makers is the problem of conveying the clay from the clay pit and delivering it to the grinding pans with the least amount of trouble and hand labour. A method of conveyance often used is by the employment of aerial wire ropeways, which deliver the clay automatically into any of the grinding pans on the route of the ropeway. Ropeways, however, suffer from the defect that the loading terminal, which is necessarily of heavy construction, cannot be readily moved about on the floor of the clay pit to follow up the receding clay face as excavation proceeds.

Several methods have been tried to get over this inconvenience. That now to be described involves the use of belt conveyors for collecting the clay and delivering it automatically into the ropeway buckets, and is believed to be the first example of a combination of multi-bucket excavator, conveyors and an aerial wire ropeway. This installation, which is delivering clay to a brickworks in the southern half of England, is shown in plan in Fig. 5. The excavator and conveyor were placed on the top of the face, as shown in Fig. 6, with the ladder of the excavator extended downwards as shown and the face was lengthened to 400ft. The ground rises in the direction in which the face is advancing, and the line of face was chosen as nearly level as possible, so that the excavator could be driven easily in either direction.

In this arrangement two belt conveyors are used, made by Mavor and Coulson, Ltd., of Glasgow. The one marked G-H in Fig. 5 is the main conveyor and is intended to advance forward in the direction of G as excavation of the clay proceeds. The second, marked J–K, is a face conveyor which delivers on to the main conveyor as shown in Fig. 1. Installing, moving and maintenance of the face conveyor are simplified by the makers' sectional construction, which enables the conveyor to be readily moved backwards as excavation proceeds. Inverted troughing is used to support the idlers and protect the bottom belt, and the clay is delivered from the face conveyor to the main conveyor by means of a small hopper.

The excavator is of the ladder type and was made by Stothert and Pitt, Ltd., of Bath. It runs along a rail track about 400ft. long on top of the bank and parallel with the face conveyor. The face conveyor receives its clay from a balanced chute seen behind the excavator in Fig. 2. The chute is of Mavor and Coulson's patented construction, which is claimed to ensure regular delivery of the clay to the band. The belt of this conveyor is 24in. wide and runs at 166ft. per minute. It has a capacity of 40 tons per hour and is driven by a 6 H.P. electric motor. The excavator tracks and the face conveyor are moved about 13ft. back from the advancing clay face once a month. The belt of the main conveyor is also 24in. wide, but it runs slightly faster than the face conveyor so as to guard against congestion at the receiving point.

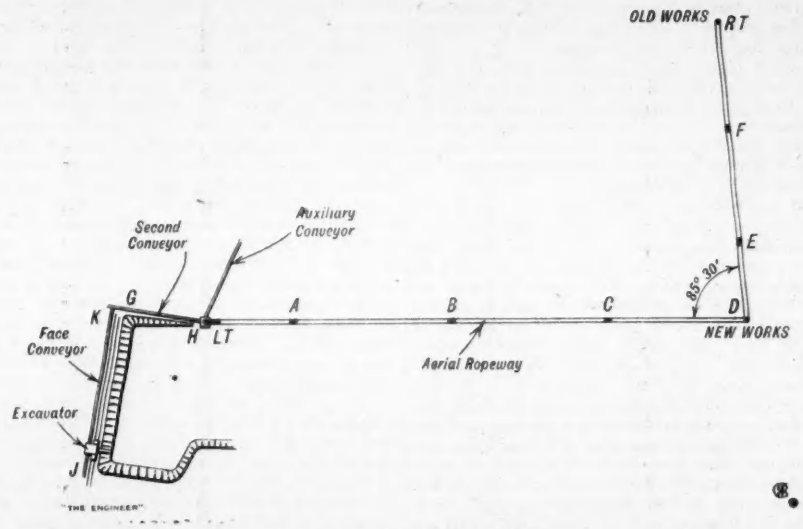


FIG. 5—PLAN OF INSTALLATION

The main conveyor delivers the clay to a nearly vertical chute, 7ft. 4in. long, which catches the clay leaving the belt and directs it downwards and slightly backwards into the buckets of the ropeway. One man only attends to this loading process. The connection between the conveyor and the ropeway loading terminal is shown in Fig. 2. The aerial ropeway, by R. White and Sons, of Widnes, is 2360ft. long, with a capacity of 40 tons per hour in loads of 10 cwt. of shale and clay, with a despatch of eighty loads per hour. The steepest gradient is 1 in 14 and the ropeway is driven by a 15 H.P. electric motor. The standards supporting the ropeway vary from 25ft. to 45ft. in height and the clay is delivered automatically by means of Messrs. White's selective method of tipping at two different stations D and R T., Fig. 5. The angle station D is 35ft. high with an angle of 85½ deg., and is so arranged that the clay can be automatically tipped at this point, or, if not required there, it is carried on through the angle station and automatically tipped at the return terminal R T. Fig. 7 shows a bucket at the loading terminal receiving its load of clay down the vertical chute already mentioned. The angle station D is illustrated in Fig. 3 and the return terminal station in Fig. 4.

With the exception of the driver on the excavating machine and the men in charge of the two grinding pans, only two men are employed on the whole of this installation. It has now been working for about two years and, we understand, has given complete satisfaction.

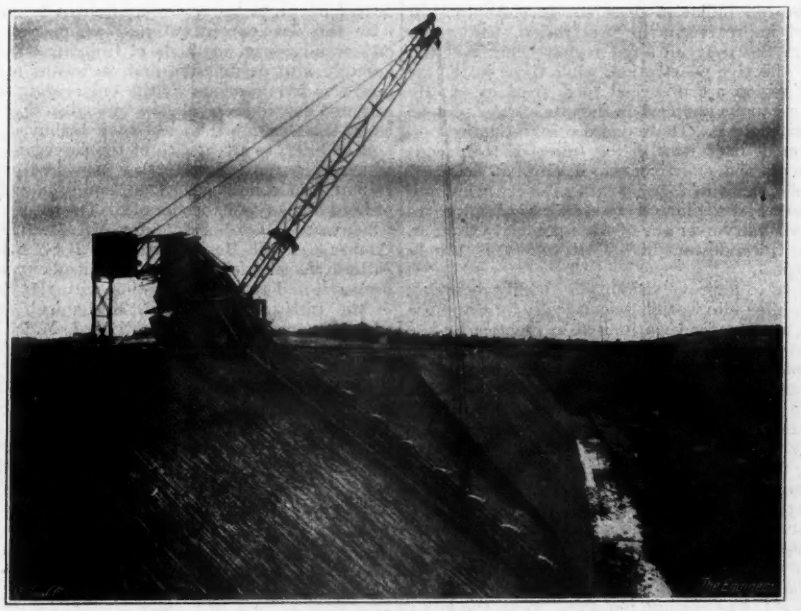


FIG. 6—EXCAVATOR AND CLAY FACE

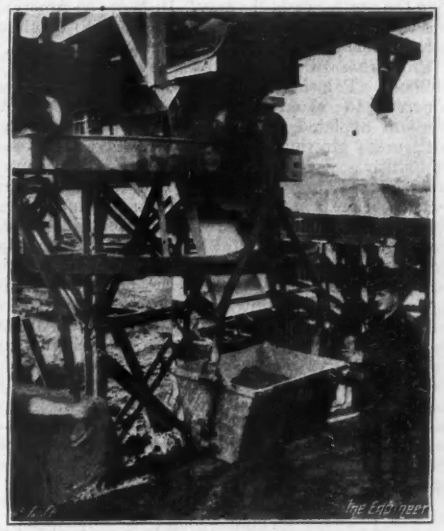


FIG. 7—BUCKET AT LOADING TERMINAL

Airport Protection and Defence

AIRPORTS and air fields or air bases that are liable to military attack from the air need protective measures of two distinct types. First, what may be called passive protection in the way of concealment or bomb-resistant construction; secondly, active protection by means of aeroplanes and anti-aircraft guns. This axiomatic statement is substantially the theme of an article published by the American Society of Civil Engineers in the December issue of *Civil Engineering*, the Society's monthly magazine. But while the conditions outlined are practically axiomatic, it appears that American airports are "extremely vulnerable to an aggressive attack in force from the air," according to the author, Mr. LeRoy M. Hersum, a consulting engineer. The reason for the apparent deficiencies in protective features of American airports and air bases, which are noted by the author, obviously lies in the fact of that country's isolated position, so that such measures have constituted a practically negligible factor in design. However, they have not been neglected in coast defence works, and will undoubtedly be given greater consideration in the air bases now being planned and built by the United States Army and Navy authorities.

These wartime conditions apply, of course, to civil as well as to military airports, but Mr. Hersum states that ordinary civilian airport design is characterised by a high degree of concentration in the interest of economy of operation, and by a conspicuous lack of camouflage, fire protection and dispersion of the various facilities. Thus, the construction of numerous civil airports may be actually a disadvantage, since they invite an enemy landing. Schemes for protection are included in the article, a condensation of which is given in the following matter.

Airport protection may be provided by: (*a*) Combat aeroplanes at the airport; (*b*) aeroplanes at a sub-airport within a supporting distance; (*c*) anti-aircraft artillery; (*d*) concealment and camouflage, or (*e*) bombproof shelters, with cover for the aeroplanes, personnel, and equipment. The possibility of sabotage must also be considered. An airport in flat country or in flat area between hills is probably harder to find from the air than one adjacent to a large river or bay. Furthermore, most American airports have their administrative buildings, hangars, and petrol storage tanks grouped or set in a line that presents a target when the airport is discovered. Even if only one or two aeroplanes should succeed in getting the attack home, the large number of aeroplanes in a hangar or group of hangars of steel construction might be destroyed. And successive attacks from different directions might be difficult to ward off by the limited number of anti-aircraft guns available. Again, with "the high fire hazard which characterises present-day American airports a single enemy aeroplane might have success."

The idea of facilities for placing the light pursuit

aeroplanes in the air from protected hangars is sound. Heavier aeroplanes would not be rushed out for local defence and would therefore require protection only. The pursuit aeroplanes should be at runway level and should be able to warm up in bombproof shelters and to take off at high speed in the dark as well as in daylight. Special designs for military and naval air bases include the principles of protection, concealment, dispersion, and camouflage, and it is recommended that the United States authorities should give the matter careful study. In fact, the American coast artillery service takes great pains to eliminate possible means of identification for fortified points.

Protection of a large base by concealment is difficult. Painting might be helpful, or coloured concrete to blend with the surroundings. Mr. Hersum explains that steel gratings for runways, with grass growing through them, have been used at British airports. Natural camouflage by planting trees, shrubs, and grass is also practicable, careful consideration being given to the general landscaping. Dispersion of storehouses, quarters for officers and men not on duty, hospital buildings, and recreation grounds is desirable, only the essential structures, equipment, and men being at the field. This principle can be carried further by the construction of sub-bases within a supporting distance. Another method is the use of one field with exposed runways for training and routine flying, and another field or fields and sub-bases without formal runways to be held in reserve for use during an attack. While anti-aircraft artillery in concealed and protected positions is desirable, the best defence, in Mr. Hersum's opinion, is the provision of pursuit aeroplanes at the airport or sub-base.

Of particular interest are Mr. Hersum's notes on proposed buried or underground hangars, although he gives no detailed design or description. In a generally flat area, the most effective type of bombproof shelter for heavy aeroplanes would be a subterranean hangar having individual cells, and with lifts or elevators, ramps, and runways for exits and entrances. A plan for a rectangular hangar built into a hillside has a central space flanked on each side by six separated cells 100ft. square, with bombproof roof covered with earth. In open or flat country the subterranean type would be the most efficient. As an alternative, the roof might be left exposed and utilised as a runway or parking space. In such case, the roof slab and paving slab would be separated by a sand cushion, the upper slab being relied upon to burst bombs falling upon it. It is considered doubtful, however, whether the additional cost of this construction would be warranted.

In proposed radial arrangements of hangars, five hangars for eight planes each are connected to form a five-point star, with radial ramps extending outward from the several hangars. An alternative to this arrangement has the five hangars at the points of the star with runways or ramps extending inwards towards the centre. Supplementary ramps at the outer ends of these hangars would provide emergency exits. Shelters of this kind would be equipped with petrol and water pumps, air-conditioning equipment, fire and gas protection, and lighting and heating plants. Structural design might be of reinforced concrete or steel, but all-steel framing would have fireproof covering.

Attention is called by the author to the disadvantages of bombproof shelters in lack of flexibility, reduced number and size of entrances and exits, and the difficulties of ventilation, drainage and servicing. Units designed for one type and size of aeroplane could not accommodate larger aeroplanes that might be developed, and aeroplanes damaged at the entrance or exit might block the entire section. Air conditioning and gas protection are expensive, and the construction costs are much greater than for light hangars on the surface. Consideration must be given also to the increasing size, weight, and power of aerial bombs.

That in wartime there is little difference between military and civilian air fields is pointed out by Mr. Joseph D. Lewin, a consulting engineer, in a discussion of Mr. Hersum's paper. He disapproves of the suggestion for an exposed roof over a subterranean hangar or shelter, since it exposes two vital elements to a single projectile. A crater in a normal runway may easily be filled with earth, but the repair of a runway over a damaged roof would be less simple. A type of construction for buried hangars, as suggested by Mr. Lewin, consists of a laminated arch roof of 120ft. span and 80ft. rise, with 35ft. of cover over the crown. The roof consists of two concentric arches of reinforced concrete, separated by an arch of cinder concrete. In line with this suggestion, Mr. Lewin says: "Because the unique problem involves also vibration, impact, suction, and other forces, too much time should not be spent in trying to apply the conventional types of construction. Instead, the ingenuity of American engineers should be directed toward creation of new and progressive forms."

COKE FOR AMERICAN STEEL WORKS.—Arrangements have been made for Great Britain to supply America with substantial tonnages of coke to assist in keeping the American steel industry at full capacity operation.

The Pallid Veil*

THE atmosphere near the earth's surface, even when not fouled by man, is full of microscopic particles—mainly salt crystals near the sea, more often the results of abrasion and combustion farther inland. Over industrial areas, droplets of sulphurous acid are prominent, estimates being made that, on a winter day, the city of New York vents into the air above it some 2000 tons of sulphur dioxide. In sections of heavy pollution, from several hundred to many thousand tons of sulphur compounds, carbon particles, and assorted dusts may settle on each square mile in the course of a year.

Many of these solid and liquid specks are hygroscopic and form excellent nuclei for water droplets when the temperature of the atmosphere falls to the dew point. Although fog would form with considerable difficulty in an atmosphere entirely free of nuclei, hygroscopic particles are always so common in Nature that the fog droplets utilise but a small fraction of those available. Fog droplets are small, generally under 0·002in. in diameter, but the nuclei are so much smaller that they constitute scarcely one part by weight in 10,000 of fog. To produce the conditions of limited visibility and clammy feeling known as fog, a cubic metre of air need not contain more than 0·1 gramme to 0·4 gramme of water as fog droplets. Visibility, in fact, is a means of defining fog, that phenomenon being usually regarded as a cloud which envelopes the observer and which reduces the horizontal visibility to 1000 m. or less. In city fogs, whose droplets are generally smaller than those of sea fogs, visibility may be considerably less for the same water content. Much of the basic knowledge on the properties of fog was not available until quite recently.

Natural fog has many structural counterparts in industry, common types being the oil fogs sometimes seen in automobile exhausts and the tar fogs that form in coal gas and coke oven gas as they drop in temperature after leaving the retorts. Here an envelope of oil or tar forms about carbon nuclei. Probably the best-known type of industrial fog is the stable and destructive mist obtained when waste gases carry sulphur dioxide, sulphur trioxide or sulphuric acid into the atmosphere. Among methods used to combat it are electrical precipitation and a recently announced absorption process in which the mist is bubbled through water containing special foaming agents, the most effective being the "green acid" obtained from the sludges of oil refining plants. A very fine spray of new design has recently been found effective in absorbing chemical fogs which are passed through a special cyclone scrubber.

As may be gathered from the ease with which it will tie up traffic, slow ships to a crawl, ground aeroplanes and hurry already weakened individuals into eternity, even stronger incentives exist to reduce natural fog. The remarkable fog that covered the valley of the Meuse in Belgium from December 1st to 5th, 1930, was accompanied by thousands of cases of respiratory troubles, over sixty human deaths on the third and fourth day, and many fatalities among cattle and small animals. Other evidence exists that the frequency of pulmonary and cardiac failures increases in industrial areas in periods of heavy fog. To a world port, furthermore, the cost of transportation delays is measured by the millions of dollars. At La Guardia Field, New York City, for example, a fog in late December, 1940, forced the cancellation of 617 aeroplane flights in a period of two days.

Attempts to improve visibility by artificial illumination are stymied by the thoroughness with which the myriads of tiny fog particles, up to 100 per cubic centimetre, scatter light. The action is as effective at one visible wavelength as at another; even infra-red radiation does not give a practical degree of improvement in penetration, the wavelengths in the near infra-red region being still too short for effective penetration, while those in the far infra-red region are absorbed to a great extent by the water vapour and carbon dioxide always present in the atmosphere. The numerous investigations on the action of light rays in fog (most of them concerned with the effectiveness, if any, of coloured automobile lights in foggy weather) overwhelmingly conclude that, if a coloured beam shows any improvement in visibility over one of equal intensity from an unfiltered incandescent light, the effect is purely psychological.

Attempts to improve visibility by bodily removing the fog, while quite feasible scientifically by a number of ways, have so far been limited in practice by the enormous dimensions of the problem. In a volume 1500ft. long, 130ft. wide and 30ft. high there may be present as fog droplets from 150 lb. to 700 lb. of water, an amount which must be removed over and over again since fogs, while ordinarily slow moving, still have velocities up to about 15 m.p.h.

While fogs can be destroyed by electrical precipitation and by supersonic vibrations, the most promising methods appear to be those which lower the relative humidity of the air sufficiently to cause rapid evaporation of the fog droplets. Houghton and Radford, of the Massachusetts Institute of Technology, have used sprays of concentrated solutions of drying agents like calcium chloride. With the latter salt, they have kept a volume about 1800ft. long, 130ft. wide and from 30ft. to 60ft. high free from fog by the expenditure of 85 gallons of saturated solution per minute. The fogs cleared away had speeds up to 16 m.p.h. The cost of drying agent used, assuming a nearby source of calcium chloride solution, would be about 220 dollars per hour. Equipment such as this, with perhaps somewhat larger capacity, might be used to clear the dangerous last hundred feet of descent for a fog-blinded aeroplane landing by use of instruments.

Houghton and Radford estimate that to keep the same volume clear by the use of heat would require the expenditure of about 5000 kilowatts continuously. The difficulty would be not in supplying the necessary energy, but in releasing or transmitting it evenly over such a volume.

* From the *Industrial Bulletin*, March, 1941.

THE JAMES FORREST LECTURE

AT the meeting of the Institution of Civil Engineers on Tuesday last, the first proceeding was the presentation of the Ewing Medal to Dr. Ricardo and the nomination of Dr. Inglis for the presidency. Then came the James Forrest Lecture by Professor Andrade. Formally it was a lecture; actually it was a talk, or even a chat about the fundamental strength of materials. The title was "The Mechanical Behaviour of Solids." Professor Andrade opened by contrasting the simplicity of gases with the complexity of the structure of solids. He then touched upon the strength of solids as calculated from their atomic structure, and said that it was under test hundreds of times, even a thousand times less than it ought to be. That led him to a discussion of why crystalline structures, such as metals, were weak, and by means of numerous photo-micrographs of single crystals, he demonstrated the influence of minute surface cracks. Still dealing with single crystals, he showed that whilst they were weak, when undisturbed they work-hardened if they were bent. A crystal of silver, for example, might be sixty-two times harder after bending than before. In answer to the rhetorical question, "Why do single crystals harden?" he replied that it was because of original defects in their molecular arrangement. They no longer remained single crystals, and "a polycrystalline metal is strong because its boundaries are weak." That paradox he took some pains to elucidate. He thought that the time might come when single crystals would be useful to engineers, but the only example so far was that of the tungsten filament in the coiled-coil lamp. Professor Andrade ended with a plea that if after the war there would be pressure for applied research, engineers would give a kindly thought to fundamental research. We understand that the lecture will be published by the Institution in a few weeks' time. It certainly deserves to reach a larger audience than that which listened to it.

ADVISORY COMMITTEE OF ENGINEERS

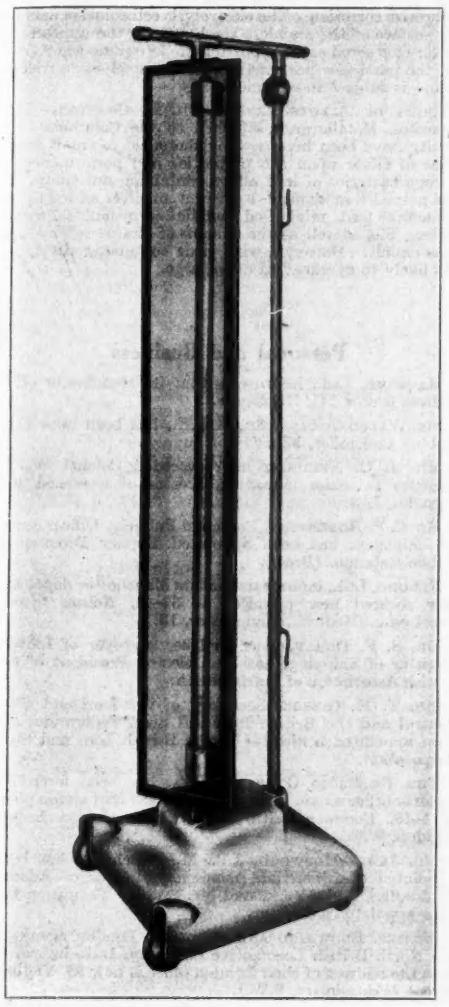
As foreshadowed in a recent issue, the Lord President of the Council has appointed an Engineering Advisory Committee to advise the Government upon engineering questions connected with the war effort, and in particular, to consider how the resources of the engineering profession can best be utilised in connection with the war work of Government Departments, and to nominate engineers who might suitably be invited to undertake particular tasks; to suggest means of improving or supplementing the methods adopted by Government Departments for utilising engineering science for war purposes; to advise on problems referred to them in connection with the development of new engineering devices, and to advise on methods of bringing such devices speedily into production, and on means of meeting new war requirements in the engineering field; to examine new ideas or devices in engineering likely to assist the war effort, to test their technical validity, and to bring to the notice of the Government those which appear to merit further consideration by the Department concerned. The Committee will consist of Lord Hankey, Chancellor of the Duchy of Lancaster (Chairman); Lord Falmouth, M.I. Mech. E. (Vice-Chairman); Sir Henry Tizard, F.R.S., F.R. Ae. S., F. Inst. P.; and of the following members, who have been selected after consultation with the Presidents of the Institutions of Civil, Mechanical, and Electrical Engineers:—Mr. J. R. Beard, M.Sc., M. Inst. C.E., M.I.E.E.; Dr. A. P. M. Fleming, M.I. Mech. E., M.I.E.E., F. Inst. P.; Mr. W. T. Halcrow, M. Inst. C.E.; Mr. B. W. Holman, A.R.S.M., M. Inst. Chem. E.; Dr. C. C. Paterson, M.I.E.E., F. Inst. P.; Mr. H. R. Ricardo, F.R.S., A.M. Inst. C.E., M.I. Mech. E.; Principal A. Robertson, F.R.S., M.I. Mech. E. Representatives of the Government research establishments and production departments will be associated with the Committee as required from time to time.

THE Secretary of State for the Colonies has approved the appointment of Mr. L. C. H. Cole as Maintenance Engineer, Transport and Harbours Department, British Guiana.

Portable Unit for Fluorescent Discharge Tubes

WE illustrate herewith the Ediswan "Portalux" lighting unit for 5ft., 80-watt fluorescent discharge tubes. By reason of its portability and adaptability to vertical or horizontal positions the unit, it is claimed, enables daylight to be brought up to, in, or under the work. In aircraft factories, for instance, it will enable "daylight" to be introduced right into the fuselage or under the wings in the horizontal position or right up to any working face in the vertical or horizontal position.

The unit consists of an Ediswan trough reflector carried in a tubular steel frame which is mounted on a heavy cast iron base. The reflector is made from sheet steel. The lamp holders are resiliently mounted on felt to protect the lamp against vibration and



"PORTALUX" LIGHTING UNIT

shock. A detachable cover fitted with armour plate glass is provided to keep the reflector and lamp clean and to protect the lacquered surface of the reflector against damage. The arrangement of the components is such that the unit is entirely self-contained and, on site, requires only the fixing of the three-core supply cable to the switch terminal. The cast iron base houses a choke, condenser and other components of the lamp control equipment, while in the tubular frame are arranged a double-pole switch and the internal wiring. The base is fitted with two rubber wheeled castors for movement when the unit is at the vertical, the same castors being used in conjunction with a ball castor at the upper end of the frame when the unit is required in the horizontal position. The frame is so arranged that the reflector may be revolved about its axis for the purpose of training the beam.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—As already announced, the Kelvin Lecture by Dr. S. Chapman, F.R.S., on "Electrical Works by Helios, or the Sun and the Ionosphere," will be delivered at the ordinary meeting of the Institution to be held on Thursday, May 8th, at 2.30 p.m. The lecture will be preceded by the presentation of the Faraday Medal (nineteenth award) to Dr. A. P. M. Fleming, C.B.E., M.Sc. (Past-President). The President, Mr. J. R. Beard, M.Sc., will also present at this meeting the Sir John Kennedy Medal of the Engineering Institute of Canada to Lieut.-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., Commander of the Canadian Forces in Great Britain. This medal is awarded annually by the Institute "for contributions to the advancement of engineering science."

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Conditions in Germany

The *Foreign Commerce Weekly*, published by the United States Department of Commerce, in an article, "Economic Conditions in Germany," says that towards the end of 1940 Germany's war industries continued to operate at capacity within the limits of available raw materials and labour. Approximately 2,400,000 positions were filled in the metal and munitions industries from December 1st, 1939, to November 30th, 1940. Of these, 775,000 were skilled metal workers, including 165,450 who were conscripted. Unskilled workmen totalled 1,632,000, of whom 208,947 were conscripted. Nevertheless, the demands of the munitions industries for skilled labour appear to be far from satisfied and the Labour Ministry emphasises the need to mobilise the available labour reserves (1) by drawing on other branches of the industry; (2) by intensifying the training of unskilled workers already employed in the metal and munition industries; and (3) by more rational utilisation of available labour. In particular it will be necessary to increase the employment of women, throttle the production of non-essential goods and to draw to a greater extent on non-skilled workers in the building trades. Referring to the coal and steel position, it is stated that the demand for coke is still in excess of supplies, and an order has been made to discontinue deliveries of coke for kitchen and individual heating stoves; whilst the coal syndicates have been instructed to reduce all unfilled orders for coke by 20 per cent. It has been suggested that the greater demand for coke is due partly to the increased consumption of low-grade German iron ore. The iron and steel situation has been alleviated by regular supplies of iron ore from Sweden and Luxemburg and by the increased production of low-grade domestic iron ore. Marshall Goering has stated that this output has doubled since the beginning of the war. It is reported that the production of iron ore in Luxemburg has now reached 8,000,000 tons per annum. Part of this is consumed in Luxemburg, but it is understood that the greater part is exported to Belgium. The steel situation in the Reich and in the occupied territories has been relieved by the steady gain of the production of the occupied countries. The Belgian output is reported to have risen from 26,790 tons in August, 1940, to 68,700 tons in September and 116,360 tons in October. The steel ingot production is reported to have jumped during the same period from 16,320 tons to 61,280 tons to 127,770 tons, with the local steel industries operating at approximately 50 per cent. of capacity towards the end of 1940. In Luxemburg and Lorraine the output of steel is recovering, since much of the damage done to the steel works from the German offensive has been repaired.

The Pig Iron Market

Quiet and steady conditions rule in the pig iron market. Most consumers have received their licences for pig iron for the third quarter and have negotiated contracts, so that the volume of business passing has naturally decreased. Deliveries against contracts are satisfactory, since supplies are reaching the consuming works with greater regularity than in the earlier part of the year. The demand for high-phosphoric foundry pig iron has expanded during recent weeks and more of the light castings foundries are being brought into the war effort. Little foundry pig iron is being produced on the North-East Coast and supplies of this quality to users in that district are received from Midland makers. Production is maintained at high level and users have no reason to complain of delays in deliveries. The Midland makers are also largely responsible for supplies of this quality of iron to Scotland; but the Scottish light castings foundries do not report any improvement in the demand for their products, and the industry there is by no means so fully employed as it might be. The engineering foundries are well employed all over the country upon Government work and their pig iron requirements reach a substantial tonnage. These are principally for low-phosphoric and hematite iron, and there is some stringency in the position of these grades. Wherever possible, consumers are encouraged by the authorities to use a proportion of high-phosphoric iron, but this is only practicable in certain cases. The distribution of imported low-phosphoric iron and hematite is being carried out by the Control to the general satisfaction of consumers, and considerable quantities of imported material are being used. Recently the demand for forge pig iron has broadened, but consumers' requirements are being adequately met. The production of basic iron is being pressed to the utmost and high outputs are being attained.

The North-East Coast and Yorkshire

The demand, whilst remaining extremely heavy, has eased in some departments, as most consumers who have obtained licences for steel during the present delivery period have placed their orders. The steel works, however, are full up with work and will have to expand operations to the utmost during the coming months to meet the requirements of users. Little of the work on hand is for ordinary commercial purposes. The needs of the war industries are on a huge scale and are absorbing practically the full output of the steel industry, leaving only an insignificant surplus for what is regarded as non-essential work and export. Few of the steel works closed down for the Easter holidays and those which did restarted with a fairly satisfactory accumulation of steel ingots. Whilst the demand from the constructional engineers for heavy joists and sections is no more than moderate, there is increasing pressure from the shipbuilding industry to obtain supplies of all kinds of steel used in the yards. The demand for plates is particularly heavy and not only are the shipbuilders absorbing large tonnages, but there is a substantial call from the wagon builders, boilermakers and tank makers. In the Yorkshire area the steel works are pressing production to a high level and all the Sheffield works are extremely busy. Some of the heavy engineering firms in that area have important contracts for overseas on hand. A satisfactory feature of the position is that the supplies of raw materials for the basic steel side of the industry are satisfactory. Acid carbon steel makers are working almost to capacity and are experiencing a pressing demand from firms engaged upon war work. The steel foundries and forges in Sheffield have enough work in hand to keep them busy for months.

Scotland and the North

Where possible, the Scottish iron and steel makers are increasing their productive capacity and, at the same time, existing plant is fully employed. The output of ingots is being maintained at capacity. There is an ever-growing demand for shell steel and special as well as ordinary steels are taken up in large tonnages by the munition makers. The shipyards are particularly busy and their requirements are accorded high priority; in fact, a feature of the present demand is the large proportion which comes within the priority classes. The output of billets and sheet bars is at a high level and is substantially reinforced by imports of finished and semi-manufactured steel, so that steel makers are thus able to meet the requirements of consumers, almost all of whom are engaged upon war work. The large amount of priority work in hand, however, has the effect of restricting ordinary commercial business, and orders for overseas destinations have also to be limited. The steel makers have an enormous amount of work in hand and for delivery during the second delivery period and will be fully occupied for months. The only department in which there has been any recession in the demand is in heavy structural steel. Plates and sections, however, are called for in increasing volume by the shipyards, whilst the marine engineering shops are taking up large quantities of castings forgings and stampings. The demand for plates is the more insistent in that the boiler and tank makers are exceptionally busy and their requirements are on an important scale. With the general engineers fully employed upon war work their needs of various classes of steel are heavy and big tonnages are being consumed by that industry. The war demand has also included the wrought ironmakers, and these mills are now holding big order books, whilst the operations at the mills and puddling furnaces are increasing. The supply of scrap to the wrought ironworks is on a good scale, but some of the works would be glad to receive larger quantities. The Lancashire steel market continues active and there has been a brisk demand from the collieries. There is also an outstanding request for most descriptions of bars, particularly bright-drawn bars.

Copper and Tin

The demand for copper from manufacturers engaged on national work continues unabated and all sections of the industry are working at high pressure. The output seems to be able to keep pace with demand pretty well, although inevitably one hears of tight spots in certain specifications from time to time, and the demand for copper and brass rod continues to strain productive capacity to the utmost. The supply of raw metal is maintained satisfactorily considering the acute shipping difficulties, which have to be faced, and there has been no deficiency of metal for priority needs. Inevitably industrial requirements have to wait and even export business is slow to receive allocations at times. Further control of prices in the United States is being discussed, and it had been anticipated that official maximum quotations would be imposed at the end of last week. For the time being, however, this action has been withheld, but the Office of Production Management has given what is in effect a mandatory indication that for the time being large producers should not quote more than 12c. per pound and small smelters more than 12·50c. per pound, and that eventually the price from all producers shall be stabilised at 12c. per pound delivered. . . . Rather quiet conditions have prevailed in the tin market and prices have eased somewhat. American buying has subsided to more normal levels and in this country, with export business dormant for the moment, activity has been only moderate. The Ministry of Supply continues to offer cash tin in the open market, but on one or two occasions recently its selling price for the day has proved to be above the level at which supplies were forthcoming from trade channels. Smelters here are now beginning to feel the effects of the shipments to America of substantial quantities of Bolivian concentrates, but it is calculated that there should be enough ore coming in to satisfy Britain's tin requirements.

Lead and Spelter

Lead continues one of the most favourably situated metals as far as supplies are concerned. Whilst the war effort is calling for increased consumption in the form of batteries and cables and probably solder, the fact that no appreciable quantities of shrapnel have so far been used in this war makes lead a somewhat less important metal than it was in the previous conflict. In addition, the slow consumption of pipes and sheets in the building industry compared with peacetime has released a large tonnage of metal for more important purposes. Similarly, the reluctance of those in areas vulnerable to air attack to paint houses and buildings as usual has led to a smaller demand for white lead, and also red lead, as the normal repainting of ships' hulls is in many cases being dispensed with or postponed. . . . The spelter position, whilst changing little in recent weeks, seems satisfactory, in that although the pressure for supplies by the defence industries remains intense, their requirements so far have been met in full by the Control from Empire sources. Indeed, it appears that armament manufacturers here have been getting their spelter with less difficulty than has been the case with some of the American concerns. This is due, of course, to the fact that in this country industrial needs have been side-tracked in the interests of the war effort, whereas in America, although a considerable degree of priority is now given to defence orders, quite a lot of metal is still going into ordinary industrial consumption.

Notes and Memoranda

Rail and Road

RAILWAYS IN CHILE.—Under a law passed by Congress at the end of 1940, Chile may have six new railways or extensions of existing systems, in all round about 450 kiloms.

FUEL FROM THE MARSHES.—Fuel is so scarce in certain parts of Russia that on some sections of the Riazan-Ural Railway locomotives have been fired with rushes instead of wood. The rushes grow abundantly near Astrachan, and over 60,000 bundles have been accumulated.

AN UNDERWATER SCHEME.—Japanese engineers have made good progress lately on the four-mile tunnel under the straits separating the main island from the island of Kynshu. This tunnel is for the railway connecting Shimonoseki in Honshu with Moji on Kynshu, and is claimed to be the longest tunnel under the sea.

LUMINOUS PAINT.—Answering a question in the House of Commons recently, Lieut.-Col. Moore-Brabazon, Minister of Transport, said that he was advised that none of the phosphorescent or luminous paints so far available could be relied upon to remain usefully visible throughout the hours of darkness. That being so, and in view of their high cost, luminous paints were not to be recommended for the marking of carriageways.

"THE DITCH."—Our American contemporary, the *Railway Age*, has no liking for the St. Lawrence waterway project, and loses no opportunity of recording opposition to what it calls "The Ditch." In a recent issue it published an article to show that pamphleteering was being tried by both sides. Short statements for wide public distribution have been issued by the Railroad Co-operative League, of Michigan, and a critical analysis has been issued by the National St. Lawrence Project Conference.

L.N.E.R. TRAIN FIRE.—It is with regret that we have to record the deaths of six boys of Ampleforth College, Yorkshire, and injury to seven others when the coach next to the rear brake van of the 12.50 p.m. King's Cross to Newcastle express caught fire between Hongham and Claypole, in Lincolnshire, on Monday, April 28th. The train was stopped, and every effort was made to extinguish the fire. The coach immediately in front and the brake van behind caught fire before the train could be uncoupled and cleared of the blazing vehicle. An inquiry into the cause of the fire is being made.

"COCK O' THE NORTH."—In our obituary notice of Sir Nigel Gresley we mentioned that the famous L.N.E.R. eight-coupled engine "Cock o' the North" "has" poppet valve gear operated by rotary cams. As a matter of fact that valve gear was removed in April, 1938, and piston valves operated by Gresley gear were substituted. At the same time that engine and others of the same, "P 2," class were fitted with a smoke-box similar to that on the streamlined "Pacific" type "A 4" class. We may take this opportunity to correct a slip about the Gresley-Yarrow engine "No. 10,000." She was not converted into a "Pacific," as we said, the 4–6–4 wheel arrangement being retained.

RAILWAY BUDGETING.—Railway interests in America estimate a substantial increase in their expenditures for both construction and maintenance of way and structures in 1941. In construction the projects that have already been authorised or are in prospect will bring the aggregate expenditure to 300,000,000 dollars compared with 250,000,000 dollars (estimated) in 1940, and 288,807,000 dollars in 1931. In maintenance the increase over 1940 will approximate 33,000,000 dollars, bringing the total for the year to 530,000,000 dollars, or the same as that for 1931, a figure that has not been equalled since that year. The figures are based on statistics supplied by the executives of forty systems.

Air and Water

POTABLE WATER STANDARDS.—The U.S.A. Public Health Service has appointed a special advisory committee of representatives from Federal and scientific organisations to study the revision of drinking water standards. Those in use were first promulgated in 1914 and revised in 1925. They are now to be changed "to conform more closely to current requirements for water supplies."

TRANS-CANADIAN AIR LINES.—It is stated by *Flight* that the figures for last year's operations by the Trans-Canadian Air Lines show a total of 5,000,000 aircraft miles flown. This is nearly double the previous year's total. During the year approximately 55,000 passengers, 100,000 lb. of freight and 1,000,000 lb. of mail were transported by the services which operate between Moncton (New Brunswick) and Vancouver, with a branch line to Seattle.

LARGE AMERICAN AIR LINERS.—News from New York has been received to the effect that Pan-American Airways has had under construction since June, 1940, nine large four-engined land-planes which it intends to put into passenger service on trans-oceanic and trans-Continental routes. They will, it is said, be capable of crossing the Atlantic in ten hours. The aircraft are described as the largest land-planes ever built, with the exception of the new Douglas B-19 bomber. The four engines each develop 2500 H.P. The gross weight of the aircraft is 43 tons, or 1 ton more than the Boeing 314s, which carry eighty-nine passengers each. The first deliveries are expected by the end of this year.

OVERCOMING A FLOOD.—Engineers engaged in the construction of a tunnel to drain the deep workings of the gold mines of the Cripple Creek district, U.S.A., have been checked in their rate of progress. The tunnel is 10ft. by 11ft. in size and ultimately is expected to be 6 miles long. During the last week in February a shot fired opened up a bad leak and as much as 20,000 gallons per minute threatened disaster. The flow came largely from a mine 500ft. above the heading of the tunnel. The 600ft. depth of water in that mine was completely drained in one week and the flow reduced to 11,400 gallons per minute. The work of re-timbering and cleaning the tunnel was started a few days later, but drilling operations could not be resumed until the flow was down to 7000 gallons per minute.

AMERICAN "PICK-UP" AIR MAIL SERVICE.—All-American Aviation is applying for permission to extend its "pick-up" air mail and freight services to seven more routes, serving about 250 cities and towns in New England, New York State, New Jersey and Pennsylvania. Aeroplanes on the "pick-up" service lower a cable to which the mail bag for delivery is attached on approaching an aerodrome. The bag is released to fall at the required spot. Mail for collection is suspended between two posts on the aerodrome and is picked up by a hook suspended from the aeroplane.

THE AIRGRAPH LETTER SERVICE.—The Postmaster-General announces that in order to meet the need for cheapening and expediting homeward postal communication from the British Forces in the Middle East, the Post Office is introducing an airgraph service, the first of its kind in the world. Under this system a letter will be less than a fortnight in transit. The charge from the Middle East to this country will be 3d. The operations of the airgraph service can be summarised as follows:—(1) The sender writes his message on a special form, 11in. by 8in. In a panel at the foot he prints the address in block letters; (2) the completed form is then photographed on to a very small film, the letter being reduced many times its original size; (3) the miniature film is sent by aeroplane to its destination; (4) on arrival of the film an enlargement measuring 5in. by 4in.—about a quarter the size of the original—is made; (5) the enlargement is placed in an envelope, with the block-printed address showing in the cut out panel, and delivered in the usual way; (6) the original letters are eventually destroyed. The homeward airgraph service from the Forces in the Middle East to this country will begin almost at once, and a similar outward service from Great Britain to the Middle East will be started as soon as the necessary technical arrangements can be completed. The airgraph service is being introduced because of the great reduction in weight and space caused by films replacing the original correspondence. Thus 4500 film negatives of letters will weigh only 1 lb. An equivalent number of ordinary letters would weigh 1½ cwt.

Miscellanea

AN IRAQ CONCESSION.—American petroleum interests have obtained a concession from the Sheikh of Kuwait to exploit the sulphur deposits in his territory. The company is already operating an oil concession in Kuwait, conjointly with the Anglo-Iranian Oil Company.

A CANADIAN LUBRICATING OIL PLANT.—In order to meet new conditions the Oil Controller of the Canadian Department of Munitions and Supply has authorised the construction by the British American Oil Company, Ltd., of a new lubricating oil plant. Heretofore the company has been a large importer of this grade of oil.

TRAVANCORE TO MAKE ALUMINIUM.—A works for the production of aluminium is to be built at Alwaye, in North Travancore. The project is in the hands of a British firm and the bauxite required will be obtained from Central India. The electrical energy required will be supplied by the Travancore State Government from Pallivasal.

FEWER SHOT-GRIT SIZES.—The Association of British Shot and Grit Manufacturers is to reduce the number of varying grades or sizes of "metallic abrasives" used in shot blast apparatus. Experiments made at the instance of the Ministry of Supply indicate that six standard grades should give the most effective and uniform operational results.

BARYTES IN CANADA.—Hitherto efforts made by the Canadian Government to increase production of barytes in the Dominion have not been successful. Small deposits have been mined in the provinces of Nova Scotia, Quebec, and Ontario, but the total output in 1939 reached no more than 300 tons. Now, high-grade deposits have been discovered near Windsor, Nova Scotia.

MINE MANAGERS' EXAMINATION.—The Board for Mining Examinations has decided to continue the wartime arrangement by which its examinations for Managers', Under-Managers', and Surveyors' Certificates are now held only once yearly, in July, instead of twice a year. The last day for the receipt of applications to sit for the July examinations is May 14th. All such applications should be addressed to the Secretary.

MOLYBDENUM SMELTER IN U.S.S.R.—It is believed that a molybdenum smelter—the first in the Soviet Union—began production at the end of last year. Situated on Lake Balkhash in Kazakstan, it will be worked by the Balkhash copper smelter, and extract the molybdenum contained in the concentrates of the copper ore mined at Kounrad, north of Lake Balkhash. The Kounrad copper-porphyry mine supplies ore for the Balkhash copper combine, the biggest operating Soviet copper smelter, which started output in 1938.

MACROME.—Considerable extensions and alterations have once again been made to the treatment plant of Macrome, Ltd., to cope with an ever-increasing demand for Macrome treatment. The new factory has a surplus capacity for the treatment of cutting tools supplied by or for customers. The treatment can be applied to all types of high-speed and carbon steel tools and gives to such tools an additional active resistance to wear, fatigue and that wasteful factor, breakage, thus considerably lengthening their useful life and increasing their output, we are informed, two or threefold and even more. An important feature claimed for the treatment is that it permeates and affects the whole bulk of the steel treated, so that the benefits are effective throughout the life of the article, no matter how many times it is reground or how much it is worn. The regrinding of treated cutting tools requires no special equipment or method; it is carried out in the usual way. The treatment is not a case hardening or deposition process and has no connection with chromium plating. It is applied when the tools are finished ground and normally regarded as ready for use.

POWER ALCOHOL FROM SUGAR.—The Australian Government has suggested to the sugar industry the desirability of making increased supplies and utilising them for the production of power alcohol, thus using the portion of the annual sugar surplus which can no longer be exported owing to the shortage of shipping. A preliminary objective of the scheme might be to produce four million gallons of power alcohol annually.

A TEST FOR STAINLESSNESS.—The Iron and Steel Division of the American Institution of Mechanical Engineers has heard a paper on the development of a small electrolytic cell, which if attached to any article of stainless steel will determine in three minutes whether or not it will resist corrosion. The electrolytic cell solution acts on the surface of the stainless steel, and by the appearance of the spot acted on, it is possible to determine whether or not the particular part of the stainless steel—as a welded seam—is subject to corrosion.

GRIDS OF ALLOYS WITH A SILVER CONTENT.—Two American Metallurgists attached to the Columbia University have been investigating the effect of small quantities of silver upon the properties and performance in storage batteries of lead alloys containing antimony. It was proved that about 0·1 per cent. of silver added to the antimony lead minimised anodic corrosion, increased battery life, as well as the amount of charge retained on open circuit. Batteries, with grids containing silver, are less likely to overheat on overcharge.

Personal and Business

MACROME, Ltd., informs us that its Manchester office address is now 241, Deansgate.

SIR WALROND SINCLAIR, K.B.E., has been appointed Rubber Controller, Ministry of Supply.

MR. J. C. NEEDHAM has succeeded Colonel W. A. Vignoles as senior managing director of Evershed and Vignoles, Ltd.

MR. C. P. ROBERTSON, Press and Publicity Officer at the Air Ministry, has been appointed Deputy Director of Public Relations (Press).

FERODO, Ltd., informs us that its Manchester depôt has now secured new premises at 33–41, Nelson Street, Chorlton-on-Medlock, Manchester, 13.

DR. S. F. DOREY, chief engineer surveyor of Lloyd's Register of Shipping, has been elected President of the British Association of Refrigeration.

MR. T. H. GIBSON, Secretary of the Iron and Steel Control and the British Iron and Steel Federation, has been appointed a director of the British Iron and Steel Corporation.

THE RUBEROID COMPANY, Ltd., has been forced to make another move. The new address of its London office is 1–19, Commonwealth House, New Oxford Street, London, W.C.1.

MR. JAMES HOPWOOD, J.P., M.I. Mech. E., has been appointed chairman and managing director of Adams-Hydraulics, Ltd., York, and Mr. Stanley Thompson has been appointed a director.

MESSRS. BROWNING AND BERTRAM, London agents of the North British Locomotive Company, Ltd., inform us that the address of their London office is now 82, Victoria Street, Westminster, S.W.1.

THE Pennsylvania Railroad has recently made the following appointments:—Mr. W. R. Elsey, general superintendent of motive power; Mr. C. K. Steins, mechanical engineer; and Mr. H. W. Jones, chief of motive power.

MR. THOMAS NORMAN FREDERICK SMITH and Mr. Charles Walls have been elected to the directorial staff of Thomas Smith and Sons (Rodley), Ltd. Both have been long and closely associated with the firm, Mr. Smith being the son of Mr. Fredk. H. Smith, the joint managing director, and Mr. Walls having been for the past twenty years general manager of the company.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Chemical Engineers

Tuesday, May 13th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Economical Raising of Steam in Small and Medium-size Boiler Plants," G. W. Himus. 2.30 p.m.

Institution of Electrical Engineers

Thursday, May 8th.—Savoy Place, Victoria Embankment, W.C.2. "Electrical Works by Helios, or the Sun and the Ionosphere," S. Chapman. 2.30 p.m. Annual general meeting, 3.45 p.m.

Institution of Engineers-in-Charge

Friday, May 9th.—Holborn Restaurant, High Holborn, W.C.1. Annual dinner. 5 for 5.30 p.m.